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An examination of nutrition informatics in hospital foodservices and the eHealth readiness of dietitions: Are dietitians ripe for disruption?

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AN EXAMINATION OF NUTRITION INFORMATICS IN HOSPITAL FOODSERVICES AND THE EHEALTH READINESS OF DIETITIANS.

Are dietitians ripe for disruption?

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DEDICATION

On 24 Sept 2013, early in my candidature, my father passed away over a relatively short but traumatic period. His passing, like his life, was dignified and honourable. He was a remarkable leader and dedicated primary school teacher and gymnastics coach to thousands, who I admired and respected deeply. I'm grateful that he was my dad and for his influence and presence in my life, providing me with stability, guidance, wisdom and a wonderful sense of humour (in his and my opinion). He was a major influence on this journey and during his illness and passing I deeply questioned this path despite my passion for the topic. However, my parents instilled in me to always do my best and to never give up, and so, on this path I continued with a resolve to keep a healthy balance of work, life and family. To reflect my gratitude for his support and encouragement in my pursuit of furthering my study and developing myself,

I dedicate this thesis to him – Kevin Maunder, Dad.

"A quitter never wins and a winner never quits."

Napoleon Hill

US author on personal success (1883 – 1970)

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PUBLICATIONS AND PRESENTATIONS

Peer reviewed journal publications in support of this thesis

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Awards

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GLOSSARY OF ABBREVIATIONS

Academy	Academy of Nutrition and Dietetics (United States of America)
AdvAPD	Advanced Accredited Practising Dietitian
Agency	Australian Digital Health Agency
APD	Accredited Practising Dietitian
BMI	Body Max Index
BMOS	Bedside electronic meal ordering solution
BYOD	Bring your own device
CBORD	The CBORD Group
CHIA	Certified Health Informatician Australasia
CPD	Continuing professional development
DAA	Dietitians Association of Australia
EHR	Electronic health records
eMOS	Electronic meal ordering solution
FeRD	Framework for eHealth Readiness of Dietitians
FHIR	Fast Healthcare Interoperability Resources
FNS	Food and Nutrition Solutions (The CBORD Group)
HIAC	DAA Health Informatics Advisory Committee
HL7	Health Level Seven International
HIMSS	Healthcare Information and Management Systems Society
HISA	Health Informatics Society of Australia
HIT	Health Information Technology
IDNT	International Dietetics Nutrition Terminology
IHTSDO	International Health Terminology Standards Development Organisation
IS	Information systems
IT	Information technology
NA	Nutrition Assistant

NCPT	Nutrition Care Process Terminology
NEHTA	National E-Health Transition Authority
NHMRC	National Health and Research Council
NSW	New South Wales
RCT	Randomised control trial
RS	Room service
SGA	Subjective Global Assessment
SLR	Systematic Literature Review
SNOMED-CT	Systematised Nomenclature of Medicine-Clinical Terms
SPSS	Statistical Package for the Social Sciences
US	United States of America

GLOSSARY OF TERMINOLOGIES

CHIA	Certified Health Informatician Australasia – credentials by the CHIA Partnership Board – Australasian College of Health Informatics (ACHI), Health Information Management Association Australia (HIMAA), Health Informatics Society of Australia (HISA).[1]
DAA Fay McDonald Scholarship	'The scholarship is to provide financial assistance for an individual planning a combination of formal postgraduate study, supervised traineeship or work experience, or a study tour to develop higher level skills in foodservice management applicable to the work of dietitians in a healthcare setting.'[2]
Digital Disruption	'Changes enabled by digital technologies that occur at a pace and magnitude that disrupt established ways of value creation, social interactions, doing business and more generally our thinking.'[3]
eHealth	Refers to electronic processes and communication that support or enable healthcare practices.[4]
eHealth readiness	eHealth readiness means the preparedness of healthcare organisations, societies, or in this case dietitians, to participate and succeed with eHealth implementations.[5, 6]
Electronic Health Record	'A longitudinal electronic record of patient health

(EHR)	information generated by one or more encounters in any care delivery setting. Included in this information are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunisations, laboratory data and radiology reports.'[7]
Epistemology	'The philosophical theory of knowledge. Epistemology seeks to define the nature, derivation, scope and reliability of the claims of knowledge.'[8]
Health Information Technology (HIT)	'A wide range of products and services—including software, hardware and infrastructure—designed to collect, store and exchange patient data throughout the clinical practice of medicine.'[9]
Information Systems (IS)	The 'software and hardware systems that support data-intensive applications.'[10]
Information Technology (IT)	The technology to treat information. 'The acquisition, processing, storage and dissemination of vocal, pictorial, textual and numerical information by a microelectronics-based combination of computing and telecommunications are its main fields.'[11]
Interoperability	The ability of health information systems to work together within and across organisational boundaries in order to advance the effective delivery of healthcare for individuals and communities.[12]

Nutrition Care Process (NCP)	A standardised approach to guide Dietitians in providing high quality nutrition care. NCP consists of four steps: Nutrition assessment, diagnosis, intervention and monitoring/evaluation.[13]
Nutrition Care Process Terminology (NCPT)	The standardised language used to support the NCP. The NCPT provides over 450 standardised terms to reflect each of the four steps of the NCP. NCPT is a controlled vocabulary to enable consistency of care and facilitate electronic health documentation.[13]
Nutrition informatics	'The effective retrieval, organization, storage and optimum use of information, data and knowledge for food and nutrition-related problem solving and decision making. Informatics is supported by the use of information standards, processes and technology.'[14]
Paper menu	A printed list of menu options for the three main meals and sometimes mid-meals which is provided to patients in advance (usually 24 hours).
Room service	Computerised call centre and hotel-style kitchen, enabling patients to call and order food when and however frequently they would like, usually during a set period (usually around 12 hours), from a one day menu.[15]

Software	For the purpose of this document, relates to application software. This is an electronic system used to accomplish specific tasks, enabling data to be managed, reported and analysed.
Spoken menu	Computerised system allowing diet office staff (such as Nutrition Assistants) to visit patients daily to assist them with making their menu selections.
Standard	‘A document established by consensus and approved by a recognised body that provides for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.’[16]
SurveyMonkey®	Online survey tool.

ABSTRACT

Technology has rapidly advanced over recent decades, and despite the healthcare environment lagging in technology adoption, it is now accepted as integral for improving efficiencies, reducing costs, supporting research and ultimately enhancing patient care. As with healthcare more broadly, the Australian dietetic workforce is also lagging with technology adoption and involvement, therefore a study examining this area is both timely and warranted. The hypothesis examined in this thesis was that nutrition informatics could provide valuable benefits for dietitians, however the dietetics profession is not yet sufficiently ready for eHealth opportunities.

This thesis explores this topic using a mixed-methods approach across three key phases, investigating from several perspectives. The first phase involved two experimental case studies in both a private and public hospital, comparing a bedside electronic meal ordering solution (BMOS) to a paper based model. Both studies demonstrated comparable results, with the private hospital cohort (n=119) preferring the BMOS (80%) and increasing their daily energy and protein intakes significantly (6273kJ to 8273kJ; $p<0.001$, and 66g to 83g protein; $p=0.001$). The public hospital cohort (n=188) also preferred the BMOS (84%) and increased their energy and protein intakes significantly (5513kJ to 6232kJ; $p=0.035$ and 53g to 78g protein; $p<0.001$). No additional staff were required, however direct patient interaction increased significantly ($p<0.001$), highlighting that significant nutrition care benefits can be achieved through the implementation of an eHealth solution.

The second phase involved a systematic literature review (SLR) and semi-structured interviews (n=10), revealing there were no guiding theories or frameworks to determine the eHealth readiness of dietitians. This research resulted in an inductively developed Framework for eHealth Readiness of Dietitians (FeRD), which encompasses five key eHealth readiness dimensions: *access, standards, attitude,*

aptitude and *advocacy*. The FeRD builds on existing theories and models, and provides a conceptual model for developing eHealth readiness evaluation tools to examine, measure and drive strategies to better prepare dietitians for eHealth. In addition, it provided a framework to analyse and report on the results of the final studies.

The final phase involved two national surveys (n=747 in 2013 and n=417 in 2016) of Australian dietitians and in-depth interviews with nutrition informatics experts (n=10). The surveys provided baseline data and an indicative trend of dietitian eHealth readiness, demonstrating a moderate level of eHealth readiness by Australian dietitians, however with limited progress over the three years. The key areas identified for improvement were the awareness of the broader benefits of eHealth (*attitude*); the low levels of experience with eHealth initiatives (*aptitude*); and *advocacy*, as the majority of dietitians (73%) have 'no role' in eHealth solutions. The interviews revealed four main themes: benefits of eHealth for dietitians; risks of dietitians not being involved in eHealth; dietitians are not ready for eHealth; and strategies for improving eHealth readiness. The most commonly reported risk was if dietitians do not embrace this opportunity, others may take their place, or dietitians may be forced to use eHealth in ways that are not the most effective for practice or maximising patient outcomes. The strategies identified for improving eHealth readiness included: collaboration and representation, education, offer incentives, mentoring, national strategy, organisational leaders, nutrition informatics champions, and a supportive environment.

Significantly this research revealed the complexity of eHealth readiness and identified the lack of understanding of what readiness entails by the profession. It appears that understanding of readiness is limited to experience, and therefore is often assumed to be made up only of attitude and aptitude. This may be the key issue and the first place for the profession to focus eHealth awareness efforts. The profession is in danger of being complacent and missing the opportunities eHealth will facilitate if it does not consider all dimensions of eHealth readiness.

Five recommendations for the dietetic profession to improve eHealth readiness include: 1. recruit dietitian eHealth expert champion/s to develop and drive a national strategy; 2. develop Australian key competency standards for University dietitian graduates and for advanced practice in nutrition informatics; 3. collaborate and ensure representation on organisations, committees and institutions to advocate for the inclusion of nutrition in national eHealth policy and standards, and to ensure interoperability; 4. develop best practice criteria for the selection and use of nutrition eHealth solutions; 5. create a policy for the utilisation of demonstrated beneficial eHealth solutions that bring improved efficiency, safety and patient benefits.

The question is ‘are dietitians ripe for disruption’? It would appear that whilst there are demonstrated benefits to the profession from the use of nutrition informatics and dietitians believe they are ready and capable, in fact they are not prepared for the technology disruption inevitable in Australian healthcare. In order to implement appropriate and successful solutions that support dietetic practice, a more knowledgeable, unified and coordinated approach from the profession needs to be adopted. In addition, dietitians need to demonstrate they are the clinical leaders for nutrition, and ensure they are driving the eHealth solutions for nutrition care, not financiers or technologists. The FeRD provides a valuable tool to track dietitian readiness over time, guide the development of targeted strategies to improve their readiness, and assist the preparation for successful eHealth initiatives. It is a professional imperative to ensure dietitians are engaged and prepared, limit the risks and lessons learnt from past failures, and enable the benefits of eHealth to be achieved for nutrition care.

SIGNIFICANCE OF THIS RESEARCH

There has been no research conducted on dietitian eHealth readiness in Australia, and yet it is very important for several reasons:

1. eHealth is rapidly advancing (and has become an Australia government priority) and has demonstrated significant benefits;
2. Nutrition informatics (eHealth specifically for dietitians) offers significant benefits to the profession and their patients/customers;
3. Malnutrition continues to be a major clinical issue for dietitians, and nutrition informatics offers a complimentary tool to support the management of malnutrition and increase patient nutritional intake;
4. eHealth readiness has demonstrated the ability to reduce the risk of an eHealth initiative failure;
5. Risks of dietitians not being involved in eHealth include clinical risk, eHealth systems not suited to dietitian requirements, and the potential for dietitians to lose their professional domain.

This research is the first to attempt to:

1. Comprehensively investigate the benefits of a bedside electronic meal ordering solution (BMOS) in the private and public hospital environment;
2. Develop a framework for assessing dietitian eHealth readiness internationally;
3. Collect comprehensive data on dietitian eHealth readiness in Australia over time;
4. Examine dietitian nutrition informatics expert perceptions on the status of eHealth readiness in Australia; and
5. Make strategic recommendations for improving the eHealth readiness of dietitians, in alignment with the Australian Government's National Digital Health Strategy.

CHAPTER 1: INTRODUCTION

* The majority of Section 1.1, 1.3.3, 1.3.4 and 1.3.5 has been published in a peer reviewed journal:
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and
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* Data from Sections 1.2 and 1.4 has been peer reviewed and presented at a conference and the abstract included in the following publication:
Maunder K. (2016). Leveraging technology to support participatory medicine: Hospital focused research. Dubai Nutrition Conference, Dubai, UAE

"The Australia of the future has to be a nation that is agile, that is innovative, that is creative. We can't be defensive, we can't future-proof ourselves. We have to recognise that the disruption that we see driven by technology, the volatility in change is our friend if we are agile and smart enough to take advantage of it."

Malcolm Turnbull

Australian Prime Minister (First statement after being elected Liberal leader September 2015)

1.1 Background

Today we live in a digital world, where every sixty seconds there are 168 million emails sent, 695,000 Facebook status updates, 98,000 tweets, and 13,000 iPhone applications downloaded.[17] As our technological prowess grows we are presented with considerable challenges and opportunities within our organisations, and a rise in consumer expectations. Within healthcare, in parallel to the rise in technology, a paradigm shift from a paternalistic medical model to a personalised patient-centred approach,[18, 19] and the emergence of the e-patient is gaining momentum. The e-patient

is using technology to search the Internet for a diagnosis, find a provider, seek dietary advice, join social media for community discussions and support, and manage scheduling of medical care.[20, 21]

For centuries clinicians have documented their findings and treatments on paper records and despite the rapid advent of technology in healthcare, there is still significant use of paper records and manual filing systems in varied practice areas.[22] The sheer volume of information and medical knowledge within a healthcare environment can no longer be safely or efficiently contained within the minds of staff and paper records. The use of eHealth is rapidly increasing, and is now accepted as integral in improving healthcare delivery, access and equity, efficiency, patient safety, clinical decision-making, curtailing increasing healthcare costs, supporting research and ultimately enhancing patient care.[20, 23, 24, 20, 21, 30] Consequently, the combination of the complexity of modern healthcare; the growing legislative requirements of healthcare organisations; and the increasing demands of client expectations, make the delivery of health services to patients impossible without the support of technology.

Dietitians are allied health professionals who play a critical role in the delivery of nutrition-related healthcare across a wide variety of practice areas, and are involved in the provision of suitable food choices within the healthcare setting. Integration of eHealth will inevitably impact dietetic practice, but the level of dietitian engagement will significantly impact the outcomes for both dietitians and their patients. Nutrition informatics is defined as 'The effective retrieval, organisation, storage and optimum use of information, data and knowledge for food and nutrition-related problem solving and decision making. Informatics is supported by the use of information standards, processes and technology.'[25]

Hospital malnutrition is a serious clinical issue, associated with adverse clinical outcomes and increased costs.[26] Whilst there are documented nutritional strategies to improve patient nutritional status, high malnutrition prevalence rates continue to be

reported across the healthcare setting.[27] The cost of sub-optimal nutrition is dramatically rising[28] and, with the emergence of the e-patient, dietitian readiness for eHealth is imperative to realise the potential benefits of health information technology (HIT) to optimise nutrition care (particularly in relation to reducing malnutrition) and support research.[29, 30]

eHealth readiness is complex, extending beyond a comfort with, and willingness to use technology. However, without any commonly known or utilised frameworks or tools to comprehensively assess a professions' readiness, information on the eHealth readiness of dietitians is reliant on personal opinion. If dietitians are not adequately prepared, the end result may be the introduction of nutrition-related eHealth solutions that do not meet support nutrition standards and processes; may not achieve the proposed benefits; may fail; and at worst may increase risk of adverse events.[31-39] These issues will then become the challenge for future dietitians to have to resolve retrospectively.

This research, titled 'An examination of nutrition informatics in hospital foodservices and the eHealth readiness of dietitians. *Are dietitians ripe for disruption?'*, seeks to identify what attributes reflect professional eHealth readiness; determine whether dietitians are ready for eHealth; and if not, to identify strategies to strengthen the capacity of dietitians to engage in eHealth initiatives and effectively drive successful nutrition-related HIT implementations.

This chapter describes the rationale underpinning this thesis by outlining the background and role of eHealth, as well as the importance of determining the eHealth readiness of dietitians in order to prepare them to practice in the digital age and achieve the potential benefits for patient nutrition care. The profession of dietetics is introduced as the focus of this research, as well as the practice area of hospital dietetics and foodservices, as this will be the focus area for two research studies. The chapter

concludes with an outline of the research aims and objectives and a summary of the thesis structure.

1.2 eHealth

"The most remarkable feature about twenty-first century medicine is that we hold it together with nineteenth century paperwork."

Tommy G. Thompson

US Secretary, Health and Human Services, May 2004

1.2.1 eHealth definition

Whilst there is no widespread agreement on the definition of eHealth, for the purpose of this thesis, eHealth refers to electronic processes and communication that support or enable healthcare practices.[4] However, it's also important to understand that eHealth encompasses much more than just the technological component, as defined by Eysenbach (2001): 'eHealth is an emerging field at the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterises not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology.'[40]

Whilst what eHealth encompasses can also vary, for this thesis it is the umbrella term for (but not limited to) the following:

- health informatics (collection, analysis and movement of health information and data to support health care);
- telehealth (use of telecommunications for the provision of remote healthcare services for disease prevention, health promotion and curative care over a distance);
- telemedicine (sub-domain of telehealth specifically focused on curative care);
- electronic health records (EHR) (digital version of the patient medical chart);

- mobile health (mHealth) (practice of medicine and public health supported by mobile devices and applications);
- clinical information systems (software solutions to support radiology, nursing, medical imaging for example); and
- health support systems (software solutions for health-related administrative tasks, such as appointment scheduling, patient data management and work schedule management).[41, 42]

'Digital disruption refers to changes enabled by digital technologies that occur at a pace and magnitude that disrupt established ways of value creation, social interactions, doing business and more generally our thinking.'[3] Technology is disrupting healthcare, and will continue to drive and be driven by government and organisational strategies and legislation.

Hospitals and healthcare providers are also challenged by the need to increase care delivery without increasing resource consumption, due to the ageing population and corresponding rise in chronic diseases.[43, 44] eHealth has the potential to reduce the burden on healthcare, enabling opportunities for improvement that would otherwise not be possible without technology.

1.2.2 eHealth benefits

"In attempting to arrive at the truth, I have applied everywhere for information, but in scarcely an instance have I been able to obtain hospital records fit for any purposes of comparison. If they could be obtained they would enable us to decide many other questions besides the ones alluded to."

Florence Nightingale 1859

English social reformer and statistician, and the founder of modern nursing (1820 – 1920)

eHealth strives to deliver many goals, which together characterise what eHealth is all about:

Healthcare delivery/quality

Perhaps the ultimate goal of eHealth is improving the quality of healthcare delivery. This goal is achieved through the consolidation and reconciliation of patient information; improved continuity of care (consistent and interoperable information that can be shared between all of the relevant providers); and increased levels of preventative care (such as immunisation).[45] Efficiencies gained allow for increased time to be devoted to direct patient care and enhancing the care experience for patients and healthcare providers.[44, 46] Improved access supports this opportunity, but also provides more complete and accurate information access.[43] eHealth also holds the potential to contribute to health-related behaviour modification and the management of chronic conditions.[47]

Access and equity

Access to healthcare information extends beyond the healthcare providers and to the patients, who can obtain their personal healthcare information at the right place and right time, irrespective of socioeconomic status and physical location.[45] An educated consumer improves the delivery of patient-centred care, enabling them to communicate more effectively with their healthcare provider, and empowering healthcare providers to make more informed decisions.[43]

Consumers are already accessing the Internet for health and medical information,[20, 21] and have free access to PubMed Central and PubMed Health at the US National Library of Medicine, which are open repositories for open source health information. Providing free access to quality medical literature is in demand, and can lead to increased pressure on healthcare professionals to use the evidence.[43] The scope of healthcare can also extend beyond conventional geographical boundaries, enabling solutions such as telemedicine and virtual consultations, invaluable to consumers that may otherwise impossible to reach in rural and remote populations.[47,48]

Efficiency

Well-designed, tested and implemented eHealth solutions have the potential to improve efficiencies and decrease costs by providing timely access to information; reducing the requirement to duplicate information across various records; automating basic functions; and reducing or eliminating duplication of tests.[40] The ability to store and document information and resources in one location that can be accessed simultaneously by multiple people, improves communication and efficiencies.[44, 45]

Patient safety

Patient safety can be improved through the reduction or elimination of situations that have the potential to harm patients during the course of healthcare delivery. The management of allergies and medications in one central location can lead to the reduction in adverse food or drug events. [41] Digital documentation and health information exchange of data (such as allergies and medications), especially with standardised language, offers significant improvements over paper-based records which can be illegible, incomplete, ambiguous and contain transcription errors. In addition, clinical information systems (IS) that include clinical decision support tools can alert healthcare providers to allergies, and potential drug to drug or drug to food interactions.[49, 50]

Clinical decision-making

Specifically developed clinical decision-making support tools can be incorporated into eHealth solutions. These tools operationalise the scientific evidence into clinical decisions, and if designed accordingly, can be utilised by healthcare professionals to share the decision-making process with their patients.[51] These tools can take various forms, such as clinical guidelines, warnings or alerts about drug interactions, reminders, and information about the costs of clinical diagnostic procedures.

Research

The digital medium enables easy and convenient access to valuable standardised or structured clinical data on a large scale. This data supports research into health outcomes which can contribute to better patient care and improved patient outcomes.[44]

Healthcare costs

Through the gains in healthcare operational efficiency, reduction in adverse medical events, and research opportunities to improve patient care delivery, the overall costs of healthcare can be reduced.[20]

Realising these benefits within healthcare however, is complex and requires not only the acceptance, adoption and ability to use eHealth, but also clinical leadership and professional readiness.[43] Large amounts of resources are being invested in new eHealth solutions, and if the staff do not utilise these systems or utilise them well, the benefits are not going to be achieved. In order to sustain and increase the uptake of eHealth, particularly for the niche and smaller healthcare solutions, rigorous research studies demonstrating the benefits will be required. Ensuring the most appropriate research design, cost and benefit assessment methodology, and data collection strategies will be essential for providing the decision information to increase the transferability of the results and build successful business cases.[52]

1.2.3 eHealth and participatory medicine

Treatment of disease may be entirely impersonal; the care of a patient must be completely personal.[53]

Dr Francis Peabody (1927)

(American Physician, Harvard Medical School Professor, 1881 – 1927)

In parallel to the rise in technology, a paradigm shift from a paternalistic medical model to a personalised patient-centred approach,[18, 19] often referred to as participatory medicine, is gaining momentum.[33] eHealth has the potential to support participatory medicine, but it is important to understand that technology and patient are not

synonymous, and it will be important for future eHealth initiatives that patients and their outcomes are at the centre of these solutions.

As healthcare organisations experience increasing pressure to control costs and improve patient outcomes, it will become apparent that patients can be the most cost-effective and valuable tools to assist in their own healthcare plan. Participatory medicine is a model of medical care that aims to close the chasm between the healthcare provider and the patient through collaboration and patient engagement in their own health plan. This model requires equal access to all of the patient data and equal rights in the decision-making process, understanding that the collective knowledge of the entire care team, the patient, patient groups and social networks provides the most ethical and effective approach to treating the patient. The goal of participatory medicine is to enhance the physician-patient relationship and allow both parties to bring their own expertise and knowledge to the table will ultimately produce the best healthcare plan and consequently the best outcomes.

Whilst the principles of participatory medicine have been published and incorporated to varying extents in healthcare in the past,[23] many reference the 1999 Institute of Medicine report "To Err is Human: Building a Safer Health System" as the foundation of this movement.[31] Following a year later, the Institute of Medicine published "Crossing the Quality Chasm: A New Health System for the 21st Century", which identified *patient-centered* as one of the six improvement aims, as well as recommending that information technology (IT) play a vital role in the redesign of the health care system.[32] Supporting this awareness campaign, the Society of Participatory Medicine was founded in 2009 and the Journal of Participatory Medicine launched in October 2009.

There were many advocates who were central to the participatory medicine movement gaining momentum in recent decades. Two of these include: Dr Tom Ferguson 'whose goal was to encourage medical professionals to treat clients as equal partners in

achieving better outcomes and change the entrenched practices of the traditional top-down hierarchy of the doctor-patient relationship';[54] and Dave deBronkart (e-Patient Dave) who was diagnosed with advanced kidney cancer (median survival 24 weeks) in 2007, but rapidly learned to use every aspect of empowerment, technology, and participatory medicine to beat the odds and has since worked to share this knowledge internationally.[55]

Leveraging technology to support participatory medicine can be highly effective in achieving the desired outcomes of an organisation, its health-professionals, and ultimately the patient. With the participatory medicine agenda driven by patient outcomes, technology solutions will provide opportunities for healthcare organisations to reinvent and reorientate services in ways they have not previously been able to, with the bonus of cost savings potential. Technology of all kinds can fit into the participatory medicine model, allowing patients to become engaged in their healthcare, through the use of email, EHR, patient portals, social networking sites, meal ordering in hospital and home monitoring devices for example. This is an exciting time for health professionals and organisations, where we are in a position to determine how 2050 and beyond will look for our healthcare, but it will require HIT understanding, education and engagement.

1.2.4 eHealth drivers

The journey of health into the digital age has been a slow and challenging process compared to other industries. However, there are a number of catalysts driving the transformation, including:

- increasing consumer participation with IT and demand for eHealth;
- mounting evidence of the benefits of eHealth to the healthcare community and patients;
- increasing awareness and acceptance of eHealth by healthcare professionals;
- decreasing costs for the purchase and deployment of eHealth solutions;
- improved support for standards (including interoperability);

– pressure to decrease healthcare costs.[56]

Healthcare is not as safe as the public would expect, with adverse events and preventable errors commonplace, leading to harm or death.[31, 32, 57, 58] The Quality in Australian Health Care study examined research data in 1992, and estimated 18,000 of patients would have died, and 50,000 would have become permanently disabled, in Australian hospitals as a result of an adverse event.[59] Based on this and subsequent studies, the cost of medical errors in Australian is estimated to be over $1 billion, possibly $2 billion, annually.[60] In addition, in Australia in 2008 there were approximately 190,000 medication-related hospital admissions occur each year, costing an estimated $660 million.[58] These statistics are echoed internationally, with estimations in 1999 that between 44,000 and 98,000 Americans die in hospitals from medical error, costing between $17 billion and $29 billion annually.[61]

These errors are the result of system failures to provide safe and effective care, and are rarely due to individual health professionals' intentional misconduct. Gaps in the flow of information and communication, both within organisations and across healthcare providers, has been attributed to the cause of preventable errors.[62] Whilst the measurable cost is enormous, the personal cost is immeasurable. Higher demand for health services along with a growing and ageing population, also contributes to increasing health costs. Health is the seond largest Australian government expense, expected to grow to around $79 billion by 2019-20.[63]

With a requirement to manage adverse events and curtail increasing healthcare costs, government policy plays a significant role in setting and supporting the eHealth agenda. The launch of the EHR in Australia by the National E-Health Transition Authority (NEHTA) is a prime example of an eHealth initiative. Transitioning to EHR is a priority of many international governments as part of a vision for improving the future of healthcare services and promoting a more integrated approach.[31, 32] NEHTA was established by the Australian government for the co-ordination and delivery of e-

health in Australia,[64] which in 2016 was transitioned to a new entity called the Australian Digital Health Agency (Agency).

The Agency released the National Digital Health Strategy in August 2017, which proposes seven strategic priorities, to be achieved by 2022.[56] This report states that 'Digital information is the bedrock of high quality healthcare... Digital health can help save and improve lives.'[56] The seven strategic priorities include:

1. Health information that is available whenever and wherever it is needed.
2. Health information that can be exchanged securely.
3. High-quality data with a commonly understood meaning that can be used with confidence.
4. Better availability and access to prescriptions and medicines information.
5. Digitally-enabled models of care that improve accessibility, quality, safety and efficiency.
6. A workforce confidently using digital health technologies to deliver health and care.
7. A thriving digital health industry delivering world class innovation.[56]

Whilst eHealth is a strategic priority for Australia, it's also important to understand the status of eHealth (particularly in relation to EHR) is still in the initial stages compared to other countries. For example, the US adoption of a basic EHR in 2011 was 28% (and in 2015 84%), compared to Australia in 2013 which was <10% (and in 2017 45%).[65-67]

1.2.5 eHealth risks

Although the potential benefits from the use of eHealth have been demonstrated, the risks are also substantial.[68] eHealth solutions are not always synonymous with improved outcomes, and many factors from system design and functionality through to their implementation, adoption and acceptance can impact on their ultimate success.

Whilst the determination of failure is subjective, IT initiatives are often categorised in three ways: total failure, partial failure and success.[69] Total failure would be relatively objective, and is where the initiative is never implemented, or once implemented is immediately abandoned.[69, 70] Partial failure may be more subjectively categorised, and would be when major goals of an initiative are not realised or in which significant undesirable outcomes occur.[69] Finally, success would be achieved when the major goals are achieved and there are no significant undesirable outcomes experienced.[69]

International IT solutions across all industries report a high failure rate, between 30% and 70%.[50,71] It has been estimated that large IT projects were twenty times more likely to fail than other large infrastructure projects, have a cost overrun of 200% and have a time overrun of approximately 70%.[72] Within healthcare there are some published research reports and government papers reporting IT failures, but there is still minimal literature, with suggestions that failures are often 'covered up, ignored, or rationalised, so mistakes are repeated'.[70] Figures on the outcomes of HIT initiatives reported by Heeks in 2005 suggest one-fifth to one quarter are a total failure, one-third to three-fifths are a partial failure, and only a minority are a success.[69] In addition to the cost burden on healthcare of failed or partially failed IT projects, there is also the potential to introduce patient safety risks.[73] One example of the cost of an eHealth project failure was the Victorian State Government HealthSMART project, which failed to reach its goals and extended years beyond the estimated due date. This project was aborted after over $360 million of government funding.[74] Similar eHealth project failures have been reported in other states, and other countries.[74]

The literature on HIT failure highlights that the causes are complex and extend beyond just technical issues. Other factors need to be considered, and have been categorised below as technical, sociological and organisational:

Technical

- Incomplete scope; strategic goal of the solution; inadequate specification of requirements[50,75, 76, 77, 78]
- Lack of technical expertise[75, 77]
- Inadequate understanding of the complexity health domain by IT companies[50]

Sociological

- Sociotechnical issues (interaction between people and technology)[62]; under-investment in human resource capacity-building[50]
- Insufficient or poor-quality staff training,[76, 70, 77, 78] poor timing of training[78]
- Lack of informatics/solution champion[76, 77]
- Lack of incentives/motivation for change; clear and visible benefits[70,79]

Organisational

- Insufficient procurement process/solution selection[57,78, 79]
- Lack of (senior management) sponsorship[68, 75, 76, 78]
- Insufficient budget[75]; time and resources[50,70 78]
- Unidentified stakeholders; lack of engagement of clinicians and other end users; hostile culture towards new information system (IS)[50,75,78, 79]
- Unidentified risks[75,70, 78]
- Communications[75, 77, 78]
- Inadequate project management (no clear vision for the change, scope creep, roles and responsibilities not clearly defined, inability to measure success)[78]
- Underestimation of the complexity[78]

1.2.6 eHealth readiness

eHealth readiness means the preparedness of healthcare organisations, societies, or in this case dietitians, to participate and succeed with eHealth implementations.[5, 6] In parallel with the increasing use of EHR, telemedicine, clinical IS and other software solutions, there is increasing research into technology acceptance and adoption.

However, technology acceptance research within healthcare is in its infancy, only just starting to extend beyond nursing and medical practitioners.[80, 81] In addition, in order to ensure the success of eHealth initiatives, technology solutions must meet the needs of the healthcare professional, and implementations should occur with engagement and communication amongst key stakeholders. Solutions need to enable, support and enhance practice, incorporating standards and processes required for the specific healthcare professional. Whilst models to identify, predict and manage user acceptance of technology will facilitate implementation efforts,[80, 81] without the right solution the end result may not achieve the proposed benefits or may fail and at worst, may increase the risk of adverse events.[35-39]

The assessment of readiness for healthcare innovation, and the readiness for change, has been demonstrated to reduce the risk of failure after introduction.[82-84] In order to analyse eHealth readiness and identify areas for improvement, however, a standardised framework for assessment is required. Several tools have been developed within areas such as e-business, e-commerce and e-government for example,[6] but appear to be still in their infancy within healthcare.

As noted, consumers are one of the drivers for the transformation/move towards eHealth. Australian healthcare consumers are poised to adopt technologies and assume a higher degree of participation on their health, wellness and interactions with the health sector.[85] A national survey conducted in 2015 of Australian adults examined consumers' use and interest in digital technologies to manage their health and wellness. The results showed consumers' high receptivity to personalised care and non-traditional service delivery models, with many expressing an interest in actively using tools and technologies in the future.[85] Examples include 87% of respondents reported an interest in making a doctor or hospital service appointment online and 70% interested in communicating electronically with a doctor or other healthcare professional.[85]

Outside the context of healthcare, surveys conducted by the Australian Bureau of Statistics (ABS) highlight the increasing trend for computer and Internet use over ten years (2005/2006 – 2014/2015), increasing from 60% to 85%, and 70% to 86% with Internet access at home (reaching 7.7 million).[86, 87] The ABS Census for 2010-2011 reported that 77% households are using the Internet every day, compared to the 2001 Census that reported 37% of the population accessed the Internet in the preceding week of the census.[88] In 2014-2015 for the first time information was collected on the number of hours spent online for personal use, showing 10 hrs of usage in a typical week.[87] General population use and increasing reliance on technology, such as in the banking industry, will logically be expected to progress into the healthcare industry.

1.3 Australian dietitians

1.3.1 Background

Dietitians in Australia are allied health professionals with formal qualifications recognised by the national authority - the Dietitians Association of Australia (DAA). 'Dietitians apply the art and science of human nutrition to help people understand the relationship between food and health and make dietary choices to attain and maintain health, and to prevent and treat illness and disease'.[89] Dietitians are the only recognised health professionals trained in nutrition and dietetics who specialise in the treatment and prevention of diet-related diseases. DAA acknowledges dietitians who have completed the required university qualifications and commit to ongoing training and education programs to ensure that they are up-to-date and a credible source of nutrition information, as Accredited Practising Dietitians (APD). APD is the only national credential recognised by the Australian Government, Medicare, the Department of Veterans Affairs and most private health funds as the quality standard for nutrition and dietetics services in Australia. It is a recognised trademark protected by law.[89]

At the time of this research there were estimated to be 6,500 Australian dietitians, of which approximately 80-90% were members of the DAA.[90] The profession is predominantly female (94%), with an average age of 35 years. The field is rapidly

expanding, with the number of dietitians employed increasing from 2006 to 2011 by 50%. Dietitians are located across all Australian states and territories, with the majority employed in New South Wales (NSW), Victoria and then Queensland.[91] The number of dietitians per population head is greatest in the major cities, and reduces in the regions, and reduces even further in remote locations.[90]

Dietitians work in a wide variety of practice settings, including (as per the DAA practice areas) clinical dietetics (which encompasses hospital – the domain of this thesis, and private practice), community nutrition, teaching/education, management, research and development, public health, foodservice, marketing and communication, and policy/regulation.[92] Figure 1.1 shows dietitian employment is predominantly in the area of clinical dietetics (60%).[92]

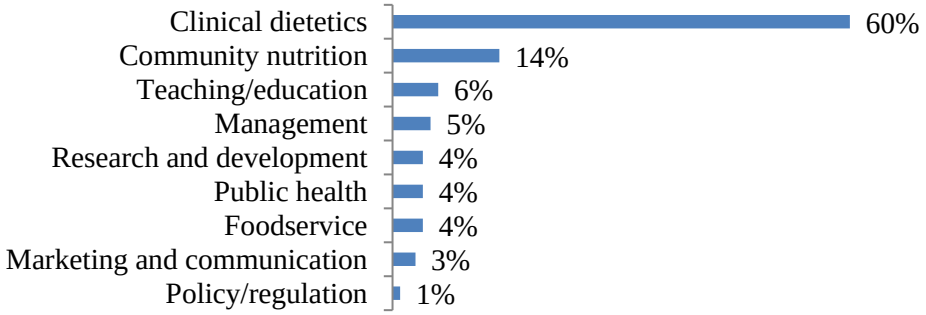


Figure 1.1: DAA dietitian employment distribution based on practice areas (2016).[81]

1.3.2 Standards of practice

Developed by the Academy of Nutrition and Dietetics (Academy), dietitians have well established and documented standards and processes to support their clinical practice compared with other allied health professionals.[39] The Nutrition Care Process Terminology (NCPT) - formerly referred to as the International Dietetics Nutrition Terminology (IDNT) - is the standardised language containing over 1000 terms categorised to describe the four steps of the nutrition care process: nutrition assessment, nutrition diagnosis, nutrition intervention, and nutrition monitoring and

evaluation. The NCPT was designed to facilitate clear and consistent descriptions of the services dietitians provide to their patients/clients.[39]

Most of the NCPT terms have been matched and modeled for inclusion in Systematised Nomenclature of Medicine—Clinical Terms (SNOMED CT) and Logical Observation Identifiers Names and Codes (LOINC), which are clinical standardised terminologies in use in Australia and around the world in EHRs. These standards position dietitians well for the transition to electronic clinical management tools, as they facilitate consistent documentation, but also support data moving across systems (interoperability). In addition to the ease of transition from paper to electronic solutions and the consistency of coding, incorporating NCPT into EHRs offers opportunities to researchers measuring outcomes and cost effectiveness, and for secondary use of data for population studies. The generation of data can be used to support and enhance dietetics practice.[39]

1.3.3 Key nutrition issues

Hospital malnutrition is a serious clinical issue, associated with adverse clinical outcomes and increased costs,[26, 93] and therefore a top priority for dietitians. A SLR conducted by the DAA determined the prevalence of malnutrition in hospitals (acute care setting) is between 20-50%.[93] Sub-optimal nutrition is associated with many chronic diseases which contribute to greater than one-third of premature and preventable deaths in Australia[94] and costs in excess of eight billion dollars per year.[28] In addition, patient nutritional status often declines during the course of admission.[95-97]

The causes of sub-optimal food intake are complex and multi-faceted, such as the patient's medical diagnosis and condition, sense of taste, dentition, swallowing ability, appetite, diet type, menu choices, gastrointestinal upsets, depression, dementia and the availability of feeding assistance and encouragement provided.[98, 99] Poor appetite is the most frequently reported reason for poor dietary intake,[27, 100] with some of the contributors to appetite beyond patient illness relating to the patient's mood,

depression status and feelings of social isolation.[101] In addition, eating patterns by patients and meal preferences can change over the period of their hospitalisation, such as a preference for smaller more frequent meals.[102]

The scientific literature demonstrates the potential of numerous dietary interventions to address patient malnutrition, including establishing nutritional goals, the provision of oral nutritional supplements or enteral feeding, and dietary counselling.[93] In addition, the scientific literature is growing in relation to the positive impact alterations in foodservice provision can make, such as a bulk meal service,[103-105] point of service,[106] feeding assistance,[107, 108] menu changes,[109] and packaging.[110]

Despite the reported high rates of malnutrition, known detrimental outcomes associated with it, and documented strategies to improve patient nutritional status, prevalence studies continue to report similar malnutrition rates across the acute care setting.[27] eHealth solutions that can support the management of malnutrition within the healthcare environment need to be identified.

1.3.4 Nutrition informatics

'Biomedical informatics is the interdisciplinary field that studies and pursues the effective uses of biomedical data, information and knowledge for scientific inquiry, problem solving and decision making, driven by efforts to improve human health.'[111] Nutrition informatics, a subset of biomedical informatics, is defined as 'The effective retrieval, organisation, storage and optimum use of information, data and knowledge for food and nutrition-related problem solving and decision-making. Informatics is supported by the use of information standards, processes and technology'.[25] In summary, nutrition informatics is the intersection of information, nutrition and technology, as depicted in the logo created by the Academy (Figure 1.2).[112]

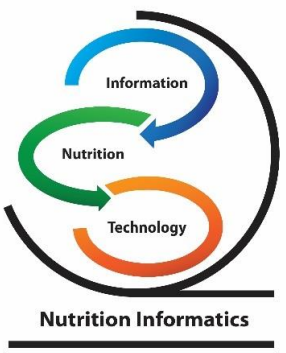


Figure 1.2: Academy of Nutrition and Dietetics nutrition informatics logo.[112]

The field of nutrition informatics is extensive, crossing all areas of dietetic practice, and is rapidly developing due to the demonstrated potential of eHealth to improve efficiencies, reduce costs, support research and ultimately enhance patient care.[20, 23, 24, 31-33] Despite only being officially defined in 2008,[113] nutrition informatics has been practised to varying degrees and consistency across dietetics for decades, including nutrient databases to examine dietary intake, computerised menu ordering systems and more broadly as a source of dissemination of nutrition information for individuals and professionals.

The first article identified on the use of computers in dietetics was from 1962.[114] Further articles on computer use in dietetics followed, and it appears the first book on the topic 'Computers in Nutrition' was published in 1979.[115] During this era, the term computer referred to a large motherboard, which required a significant amount of space, was expensive, and not widely utilised within dietetics.

Articles published from 1960 to the 1989 focused on the benefits of hospital and foodservice systems (including improved menu planning,[116, 117] elimination of data entry redundancy[118, 119] and decreased food costs[119, 120]), as well as improved accuracy in the calculation of nutrient analysis data.[121, 122] Remarkably for the time, these articles predicted that computers would be critical tools for dietetic practice. By 1990,

computer software for nutrition tasks was available in many areas of professional practice.[123]

In 1996 the term 'Nutrition informatics' was first used by Hsu-Hage and Wang who highlighted the benefits of the Internet as a means of accessing and communicating nutrition-related information.[124] Utilising the Internet for nutrition assessment tools, nutrition education and telemedicine to improve nutrition care efficiencies,[125, 126] reduce costs[127] and reach clients in rural and remote areas[127] continues to be documented in the literature.

From 1996 to 2008, articles on innovative hospital patient meal ordering processes identified opportunities to enhance patient care. Bedside menu ordering demonstrated increased tray accuracy,[128] efficiency and effectiveness,[129] labour savings,[130, 131] patient satisfaction,[128-131] nutritional intake[131] and weight gain.[132] Room service (RS) (a model of bedside ordering initiated by the patient, with on-demand meal ordering and delivery) demonstrated increased patient satisfaction[15, 133-135] and nutritional intake.[15, 133, 134] These operational innovations were made possible by technological advances allowing the use of smaller wireless mobile devices to record patient orders.

Today the topic of EHR dominates publications in the area of nutrition informatics. Articles outline tremendous potential for dietetics, such as data integration, incorporation of standards, improved monitoring, tracking and reporting, and support of research, all of which contribute to improved efficiencies, clinical decision-making, cost savings and ultimately patient nutrition care.[22, 112, 136-140] In 2014, Rossi et al demonstrated that an electronic system for capturing IDNT and NCP resulted in significant improvements in nutrition care efficiency and effectiveness for haemodialysis patient outcomes compared with a paper-based system.[141]

Across the decades of nutrition informatics literature, the shortcomings of paper records are also consistently reported. These include that they can only be viewed by

one person at a time, are difficult to store and retrieve, not always legible or compatible with data standards, and that finding data/information is often difficult. Paper records were reported to impede efforts to monitor, communicate and improve healthcare and were linked with increased medical errors.[20, 22, 142]

In order to progress from manual systems to IS, it is important to understand the requirement of a consistent and structured framework to assist in the delivery of patient care. Incorporating standardised dietetic processes and terminologies into IS can ensure accurate and consistent data entry, deliver data storage and retrieval in one location, provide standard recording and reporting processes, allow the transfer of data from one care setting to another, and enable data analysis to demonstrate patient nutrition care outcomes.[39] In turn, this data can be utilised for continuous quality improvement, which is more difficult with a manual system. Dietitians have developed standardised processes and terminology[143] and, although they are only in the early phases of adoption, these will ensure dietitians are well-positioned to transition to IS.

The technology transformation from large expensive hardware in the 1960s, to affordable, intuitive handheld devices available today has enabled rapid progress within dietetics. IS continue to be flagged in the literature as creating efficiencies in healthcare, with benefits to dietitians and patients, however there is minimal published data on best practices for nutrition systems,[29] and no clear indication of the prevalence of nutrition-related IS.

The Academy is the largest association of food and nutrition professionals in the world, representing more than 90,000 members.[144] The Academy has also led international efforts in defining and developing the field of nutrition informatics. In 2006, nutrition informatics was discussed in the Journal of the American Dietetic Association, outlining the history and current use of computers in dietetics, the application to professional practice, as well as future work for the development of nutrition informatics.[29] The Academy Nutrition Informatics Committee was founded in

2007 and has initiated numerous projects, including: defining the practice of nutrition informatics[113]; a practice paper on nutrition informatics;[14] a nutrition informatics web page[145] and blog;[146] collaborative relationships with global organisations (such as Healthcare Information Management & Systems Society (HIMSS), International Health Terminology Standards Development Organisation (IHTSDO) and Health Level Seven International (HL7) and Fast Healthcare Interoperability Resources (FHIR)); and defined nutrition informatics competencies across all areas of dietetic practice.[8-11]

The Academy designed and conducted nutrition informatics member surveys in 2008 and 2011, commencing an analysis of trends in the use of eHealth and information management by Academy dietitians.[147] The survey, which was repeated in 2014, identified an increase in adoption of, and comfort with technology, as well as an improved understanding that eHealth can assist with nutrition decision-making and problem solving.[113, 147] These results support the continuing professional development (CPD) strategies initiated by the Academy, and identify the potential for enhanced educational programs to ensure student dietitians are prepared for an electronic workplace.[10]

Anecdotally Australian dietitians are less familiar than their American colleagues with HIT and nutrition informatics terminology. However, interest and enthusiasm is developing and there has been regular publication of Australian studies on nutrition informatics at conferences.[148-153] In 2012, the DAA launched two informatics initiatives: a Health Informatics Advisory Committee (HIAC) and a member-initiated Nutrition Informatics Interest Group. The HIAC role was to advocate for and provide strategic advice to the DAA Board on dietetic involvement in nutrition informatics and the implementation of NCPT in Australia. The roles of the Interest Group are to support members with resource development, CPD and advocacy related to nutrition informatics, and they replaced the HIAC in 2016.[154] Then, in 2016 the DAA Board decided to discontinue the work of HIAC, despite HIAC member concerns about the

risk of losing an overarching group and central contact for health informatics within the profession.[155, 156] DAA advised the new structure to manage nutrition informatics work would be the Interest Group to target professional development and advocacy, and that smaller ad hoc working groups would be created for submissions and proposals as required.[155] Unfortunately, as of August 2017 the Interest Group is without a convenor and limited committee membership and is at risk of also discontinuing.[157]

1.3.5 Current use of eHealth

In Australia, no comprehensive data related to dietetic HIT usage is available. There are a limited number of small and targeted surveys on computer use by national dietetic populations[12,13] but no comprehensive national data for any other countries (including Australia)[2] beyond the United States of America (US) to our knowledge.

Computer technologies now form a part of everyday work, supporting dietitians in all areas of practice. Examples include:

- *Clinical dietetics*: Documentation of patient care via EHR; integration of the NCPT into eHealth solutions; nutrition screening; ordering of nutritional supplements; and remote care/telemedicine.
- *Foodservice dietetics:* Recipes, menus and nutritional analyses of dietary intakes; menu planning; event management; menu forecasting; inventory management; food recall management; and staffing and workload statistics.
- *Community and public health nutrition:* Population food intake analyses; digital population studies; and communication with clients and providers via EHRs.
- *Private practice and business:* Consultation and business practice survey development and management (customer satisfaction, business opportunities); financial management; nutrition (e.g. intake analysis) apps; and cost-benefit analysis.

- *Research:* Web-based search tools; nutritional analysis programs; statistical analysis software; reference management software; and leveraging digital data for outcomes evaluation. Informatics research includes the evaluation and use of standards, and methods of data aggregation and analysis.
- *Education:* Course development; distance education management; blended learning opportunities; educational resources; scheduling and tracking student progress and simulated experience.[14]

1.3.6 eHealth readiness

There is a paucity of literature on the eHealth readiness of allied health professionals (including dietitians), and there are no reported frameworks for analysis. What little information is known about dietitian eHealth readiness is limited to one report on the eHealth readiness of Australia's allied health sector from 2011.[158] This report identified the importance of clinical engagement in eHealth, and investigated the infrastructure, attitude and aptitude as dimensions of readiness.

1.3.7 Dietitian eHealth 'experts'

Whilst dietitians (like other allied health professions) require a University degree conferring graduate eligibility for the corresponding credentials, there is a difficulty in formally identifying practitioners with advanced skills within a specific practice area. Informal labels or job titles have been assigned to those working within a speciality area, such as renal dietitian, however there are no specific standards or requirements to use this label/title. The DAA has the Advanced Accredited Practising Dietitian (AdvAPD) program to formally recognise APDs who are currently practising at an advanced level. However, this is not specifically for recognising advanced practice in one field or setting, but rather recognises practise at an advanced level, which may be evident across a diversity of dietetics settings.

The Certified Health Informatician Australasia (CHIA) is a unique credentialing program for health informatics, demonstrating that candidates meet the Health Informatics core competencies to perform effectively as a health informatics professional in a broad range of practice settings.[1] The CHIA qualification has been designed to address the lack of formal recognition for health informatics skills in the Australian health workforce.[1] Currently CHIA is the closest credential dietitians have to a formal recognition of advanced skills and experience in health informatics, however only two APDs have this credential.[159]

1.4 Dietetics in the hospital setting

1.4.1 Focus on foodservices

The primary role of the dietitian, as well as the type of eHealth solution required, is dependent on the practice areas and can vary significantly. However, a key area of practice is hospital dietetics where dietitians manage acute nutritional issues, in addition to educating on longer-term dietary requirements. This area encompasses both clinical dietetics and foodservices, but for this research the primary focus was foodservices. The rationale was multifaceted, including the following key reasons:

1. The practice area of clinical (hospital-based) dietetics represents 60% of the Australian dietitian workforce (Figure 1.1);[92]
2. It is one of the more complex practice areas, with the role of the hospital dietitian spanning across the various clinical specialities (with direct patient interaction), as well as overseeing the nutrition side of the foodservice operation (such as ensuring the patient menu meets diet standards),
3. A key nutrition issue facing dietitians is malnutrition, which is widely reported in the hospital setting;[26, 93]
4. The potential to impact on the whole hospital population (large patient numbers) through one operational change;

5. Hospitals are one of the few healthcare areas where there is a government driven eHealth agenda, and so are experiencing the rapid introduction of the technology with the EHR;

6. Foodservice operations, and in particular meal ordering solutions, are often overlooked as an area of opportunity to impact patient/clinical care;

Consequently, examining the potential to achieve significant patient outcomes in the hospital foodservice environment is of significant value.

1.4.2 Foodservices and patient nutrition

Hospital foodservice has been accurately described as the most complicated production process in the hospitality sector,[160] and there are several processes related to the production and delivery of safe and suitable patient meals as highlighted in Figure 1.3.[161] However, whilst foodservice is often not considered a clinical service, it has a direct link to patient clinical nutrition care, and therefore has an opportunity to impact a large volume of patients through its service. However, the research literature is lagging compared to clinical research, and is possibly the consequence of the difficulties in conducting high quality research in foodservices. Quality assurance activities are frequently conducted in this setting, but are often not published beyond the hospital setting.

Figure 1.3 provides a summary of the many processes involved in a hospital foodservices department, and consequently the various opportunities for transformation that may impact patient nutrition care. Many processes have been analysed and continue to be monitored as part of department quality assurance projects, such as menu reviews, recipe modification (including food fortification), production processes, plating and rethermalisation processes and meal delivery solutions (plated versus bulk systems).[162]

Food intake is an integral part of a patient's nutritional status in hospital,[109] and with malnutrition identified as a key issue for hospitals and dietitians, foodservice operations play an important role when addressing the prevalence of malnutrition in the health care setting.

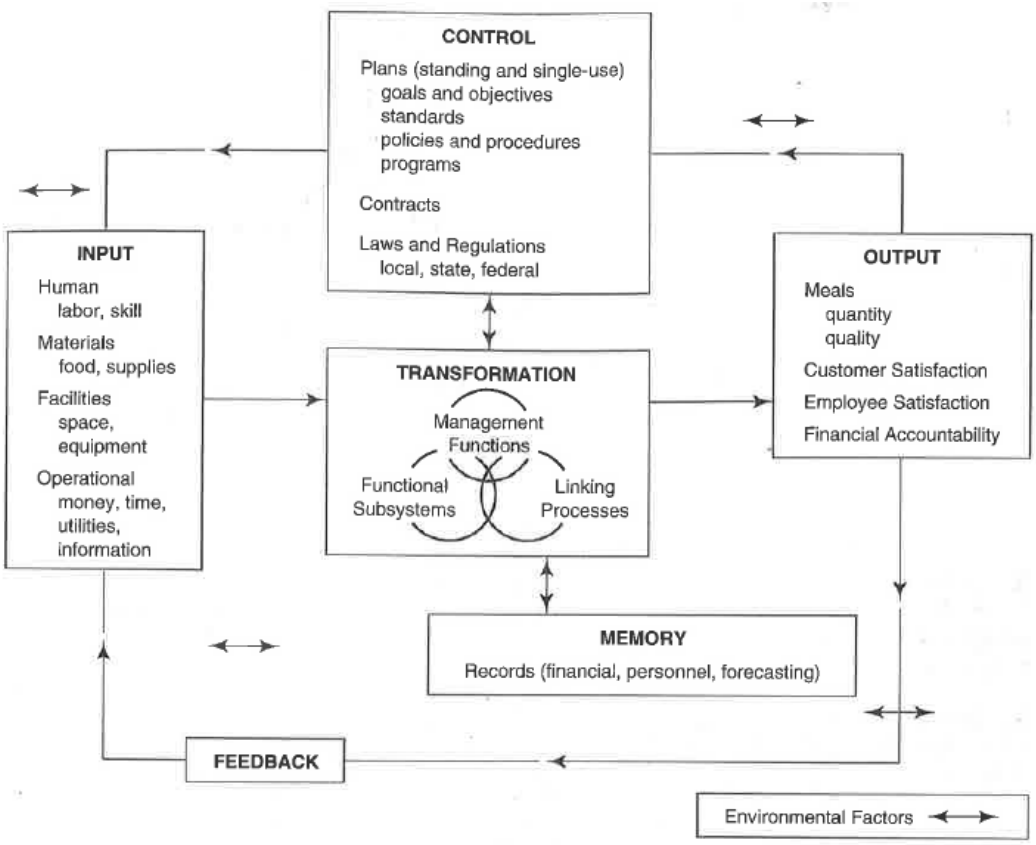


Figure 1.3: A Foodservice Systems Model[148]

Patient satisfaction is a crucial component to ensuring a major change in foodservice operations is successful, and it has also been correlated with overall hospital experience and satisfaction[163, 164] and nutritional intake.[165] Satisfaction with foodservices is therefore an important dimension of the patient hospital experience, and one of the few aspects of their care they feel some level of control and ability to critique.[166] Studies relating the role of foodservices in improving patient satisfaction, have reported mainly on the food delivery system, or qualities of the food. However, Belanger and Dube (1996) conducted a unique study investigating '...the relative

contribution of the dimensions of patient emotional experience to patient satisfaction with foodservices'.[167] Their findings suggest that patients who felt in control, and consequently felt positive emotions, reported a higher level of foodservice satisfaction. In addition, Naithani et al (2008) identified that two key organisational barriers to patient satisfaction were a menu service that does not enable an informed decision about what food meets patient needs, and an inflexible ordering system.[168] Suggestions on re-engineering foodservices to improve the nutritional status of patients would benefit from an effort to use food as a source of security, reassurance, and joy.[167]

The Nutrition Assistant (NA), or Diet/Dietitian Aide or Technician plays a pivotal role in the delivery of a quality foodservices solution in the hospital setting, as they are the human interface with patients, directly interacting with them for the meal ordering process. Studies have demonstrated that NAs assigned to providing all of the meal-related services on the wards, including taking of menu selections, increased patient satisfaction significantly.[169] These findings support the idea that if patients feel more involved, and more considered by staff through attentiveness and courtesy, they tend to feel an overall sense of satisfaction with foodservices.[167, 137]

1.4.3 Foodservice electronic meal ordering solutions

Historically, foodservice is an area that has been manually managed without the support of eHealth solutions. For collecting patient meal orders, foodservices commonly utilise a paper menu (a printed list of menu options), which is provided to patients in advance (usually 24 hours), and requires considerable staff time to be spent processing and editing patient selections in an office environment. This type of service often requires the collection of patient selections one to two days in advance of the actual meal, which can often be confusing for patients, and lacks flexibility to deal with dramatic change in patient appetite by the time of meal delivery.[128]

However, with the introduction of electronic meal ordering solutions (eMOS), patient meal ordering has advanced, supporting patient engagement (participatory medicine)

through the utilisation of eHealth solutions to re-orientate foodservice processes. In addition, as hospital standards and legislation continue to require comprehensive accountability and safety measures, whilst continuing to deliver a high quality service, achieving this is becoming difficult without an eMOS. The number of Australian hospitals offering an eMOS as an alternative to traditional models of meal ordering remains unpublished; however it has been estimated that approximately 25% of hospitals utilise a software system within their dietetic and foodservice departments.[170] Whilst the growing trend is towards electronic solutions, still a large number of hospitals continue to manage their foodservice operations manually. The progression and adoption of technology in Australian hospitals for dietetic and foodservice management is represented below in a timeline (Figure 1.4).

eMOS can be categorised into three groups: 1. bedside eMOS (BMOS); 2. RS eMOS; and 3. patient-directed eMOS. The BMOS involves staff (such as a NA) visiting the patient bedside and assisting the patient to make preferred and suitable meal selections on handheld electronic devices, answer questions, resolve issues and initiate appropriate dietetic referrals. The meals are plated on a tray line and delivered to the patient at set meal times. RS offers patients a hotel-like meal experience, where they can call and order meals when and however frequently they like from an a la carte menu, and the meals are cooked to order and delivered directly to the patient room soon after ordering. Patient-directed eMOS allows patients to order their meals via a bedside terminal (such as an entertainment system) or a "bring your own" device (BYOD), and can support the trayline or RS meal delivery solutions. Both the RS eMOS and patient-directed eMOS have only been recently introduced in Australia (2013 and 2016 respectively), so BMOS (which is used by approximately 40% of eMOS users)[170] was selected to be the focus for this thesis.

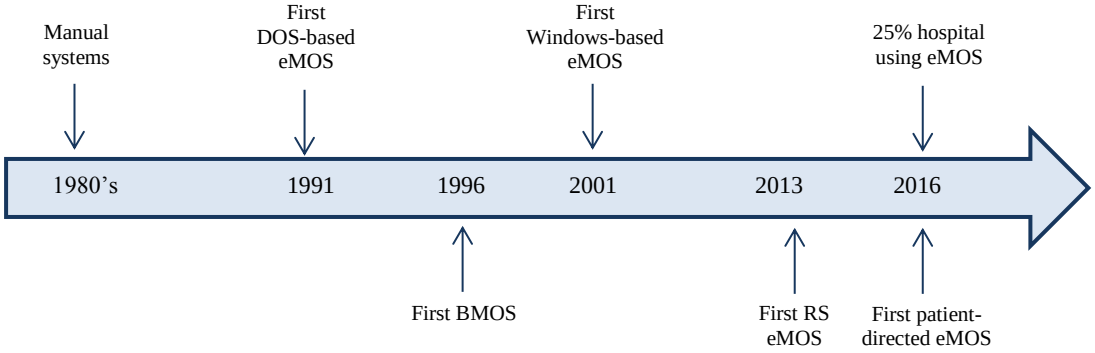


Figure 1.4: Australian hospital foodservice eMOS introduction timeline.

A systematic literature review (SLR) was conducted to identify the benefits of BMOS compared to a paper menu in the hospital environment. The SLR search protocol was conducted according to the (PRISMA) statement[171] and reported using a narrative synthesis. Searches of Scopus, CINAHL, ScienceDirect and Medline electronic databases were conducted using nine keywords, including: *meal* or *menu* and *spoken*, *ordering*, *bedside* or *service*, and/or *hospital* or *patient*, and/or *foodservice/food service*. The searches were from the earliest date within each database until February 2013, and limited to peer-reviewed English language publications. Additional papers were identified through reference harvesting of relevant papers, and a key author search.

Of the sixty five articles returned in the identification phase, ten were assessed in the eligibility phase, and nine remained for final synthesis (Figure 1.5). Forty four articles during the eligibility phase were excluded with reasons: articles that were related to another eMOS (RS or patient-directed) (n=3); the BMOS was only one part of entire research study and could not be attributed to the study results (n=2);[131, 172] author and abstract could not be sourced (n=4); or were not related to BMOS (n=35). Due to the limited number of full text articles specifically relating to BMOS, the abstract only articles were not excluded. Only one article/abstract was removed during the assessment phase as it was a conference abstract which was reported by the same author in a full text article.[129] There were a final total of nine articles, two were full-

text and seven were abstracts. All articles were reported from two countries: the US and Australia. Software solutions analysed in the studies included CBORD (4), Micros (1), and not specified (4). All selected articles were published between 1996 and 2011, with the full text articles published in 2000 and 2002 (Table 1.1).

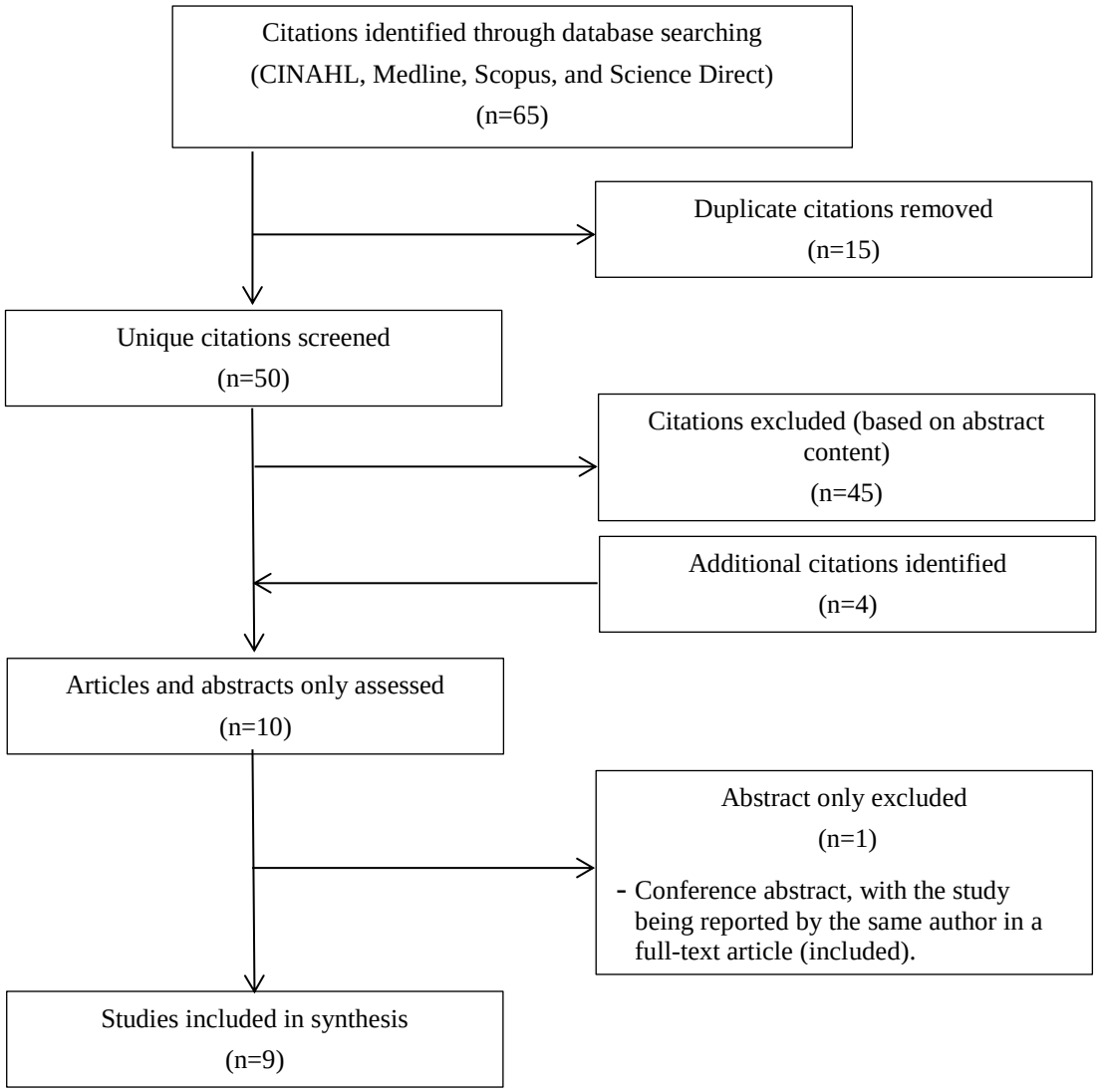


Figure 1.5: Literature search and flow diagram for selection of studies on hospital BMOS.

Table 1.1: Summary of BMOS literature

Author (year)	**Source/*Journal***	**Study title**	**Study setting & (system)/ design/**	**Outcome measure/s & Findings**
Winkler K[173] (1996)	Conference abstract *Journal of the American Dietetic Association*	Customer - focused patient meal service delivering patient meals with service innovation.	Hospital, US. (Not specified). Design not specified. Patient numbers: not specified.	Patient satisfaction: increased from 87% to >96% (1 year post implementation)
Fontenot MC et al[132] (1998)	Conference abstract *Journal of the American Dietetic Association*	The effect of hand-held menus on the body weight and food consumption percentages of alzheimer's residents residing in long-term nursing facilities.	Long-term care nursing facilities, US. (Not specified). Pre-experimental design. Patient numbers: not specified.	Weight: gain of 0.24 pounds/ month for the hand-held menu patients; and a weight loss of 1.45 pounds/ month for the control group patients.
Mosqueira et al[130] (1996)	Conference abstract *Journal of the American Dietetic Association*	Spoken menu: a menu process catered to the patients food choices and present appetite.	Hospitals (seeing older and sicker patients), US. (Not specified). Design not specified. Patient numbers: not specified.	Patient satisfaction: improved by 5% Production hours: reduced Trayline staff: reduced by one Diet office hours: decreased

Author (year)	Source/*Journal*	Study title	Study setting & (system)/ design/	Outcome measure/s & Findings
Oyarzun VE et al[129] (2000)	Journal article *Journal of the American Dietetic Association*	Evaluation of efficiency and effectiveness measurements of a foodservice system that included a spoken menu.	Tertiary care hospital, US. (CBORD). Observational trend study Design not specified – observational trend study. Patient numbers: Phase I: 44, Phase II: 46 and Phase III: 54.	Patient satisfaction with food and nutrition staff attention: increased significantly ($p<0.05$) Nursing staff satisfaction: increased for some variables. Menu processing time: decreased Patient interaction time: increased Late trays: decreased Wasted trays: decreased
Folio D et al[128] (2002);	Journal article *Journal of the American Dietetic Association*	The spoken menu concept of patient foodservice delivery systems increases overall patient satisfaction, therapeutic and tray accuracy, and is cost neutral for food and labor.	Hospital, US. (Not specified). Retrospective study. Patient numbers for satisfaction: Pre: 432, and Post: 429.	Patient satisfaction: increased significantly (varying p values for the various parameters measured) Meal costs: decreased slightly (not significantly) Labour costs: decreased slightly (not significantly) Meal tray accuracy: increased significantly
Porter J [174] (2006)	Conference abstract *Nutrition and Dietetics*	Computerised menu management systems: is micros the way of the future?	Hospital, Australia. Observational and comparison to literature. (Micros) Design not specified. Patient numbers: not specified.	Suggested advantages: responsiveness of the system; meal accuracy; and ability to make menu changes. Suggested limitations: volume of work for system setup; burden of menu changes; and inability to integrate preformatted diet codes.

Author (year)	Source/*Journal*	Study title	Study setting & (system)/ design/	Outcome measure/s & Findings
Maunder K et al[152] (2009)	Conference abstract *Nutrition and Dietetics*	Service comparison between a computerised bedside system and paper menus for private hospital patients.	Hospital, Australia. (CBORD). Pilot pre-test post-test study. Patient numbers: 54.	NA face-to-face time with patients: 60% of NA time spent with patients compared to 19% Patient receiving a selection: 92% compared to 75% Cost: BMOS $1.02/day compared to $2.60/day
O'Hanlon J et al[151] (2010)	Conference abstract *Nutrition and Dietetics*	Evaluating new ways to offer patients meals: electronic vs paper menus.	Hospital, Australia. (CBORD). Design not specified. Patient numbers: not specified.	Patient preference: higher (54%) than paper menu (26%), and no preference (20%). Food service staff preference: paper menus
Lazarus C[175] (2011)	Conference abstract *Nutrition and Dietetics*	Meals on wheels - implementation of a room service style bedside menu service.	Hospital, Australia. (CBORD) Design not specified. Patient numbers: not specified.	Patient satisfaction: increased Written commendations about the food and nutrition serviced: increased Nutrition and nursing staff relationship: improved NA to patient face to face contact: increased x3

While the literature review revealed only two published full text articles, with limited description of the study design and statistical analysis, the results highlight there are potential benefits of a BMOS over a manual paper based solution. Patient satisfaction outcomes were most frequently reported, followed by NA interaction time with patients, with only one study referring to the impact on patient weight and none specifically on nutritional intakes by patients. Other opportunities identified with the BMOS included allowing for patient menu selections to be collected closer to meal times;[131] cost savings;[128-130, 152] decreased waste;[129] and increased tray/meal accuracy.[128, 174]

Patient satisfaction with foodservices, staff attention and/or preference when reported on for the BMOS all increased.[128-130, 151, 173, 175] NA time spent interacting with patients was demonstrated to increase up to three fold.[129, 152, 175] Fontenot et al (1998) were the only authors to investigate the impact on nutritional intake, reporting weight gain in patients with BMOS, compared to weight loss with patients with the traditional service.[132] However, as this was a conference abstract, there were minimal details on methodology and statistical significance of these results.

The lack of published data on implementing software in hospital foodservice departments is not surprising given the difficulties of conducting experimental studies in this area; they can require significant resources and are often not possible due to the essential nature of the operation. Despite the growing demand within hospitals to demonstrate system outcomes, it continues to be a difficult task to resource, and therefore is rarely conducted. Consequently, high quality studies investigating the potential benefits of these implementations have not been conducted.

1.5 Literature summary

This literature review provides the contextual background for this research, providing an understanding of the benefits and risks of eHealth, an overview of the dietetics

profession and the key nutrition issues, as well as the paucity of literature on the benefits of nutrition informatics (specifically in the hospital foodservices setting) and on eHealth readiness.

Whilst there is limited scientific literature on the BMOS, there is sufficient evidence to support further investigation to confirm there are significant benefits of nutrition informatics, and in turn warrant an investigation into dietitian eHealth readiness. The eHealth readiness of Australian dietitians is unknown, and there is no clear information on how to assess and report on eHealth readiness. Consequently, there is a significant gap in our knowledge, our readiness, and ability to be prepared for the introduction of eHealth. All dietitians will ultimately have some exposure to eHealth and hence the findings of this research will have relevance to the entire profession.

1.6 Research aims

The title of this research is 'An examination of nutrition informatics in hospital foodservices and the eHealth readiness of dietitians. *Are dietitians ripe for disruption?'* It was hypothesised that nutrition informatics could provide valuable benefits for dietitians, however the dietetics profession is not yet sufficiently ready for eHealth opportunities. Therefore, this work is both timely and warranted, to determine if the profession's investment in this space is justified, and if so, how to determine dietitian readiness, and consequently best prepare dietitians to practice in the digital age and achieve the potential benefits for patient nutrition care.

The primary aim of this study was to examine the benefits of nutrition informatics in hospitals, and to critically evaluate the readiness of dietitians for eHealth. The following research objectives were examined across three phases and six studies, designed to build sequentially (Figure 1.6):

1. To demonstrate the potential benefits of nutrition informatics, by replacing a patient paper menu system with an electronic bedside menu ordering system in the hospital environment.

2. To develop and validate a framework to assess the eHealth readiness of dietitians.
3. To determine the eHealth readiness, and changes over time, of Australian dietitians.
4. To identify the perceived barriers and enablers to dietitian eHealth readiness.
5. To identify strategies to strengthen the capacity of dietitians to engage in eHealth initiatives and effectively drive successful nutrition-related eHealth implementations.

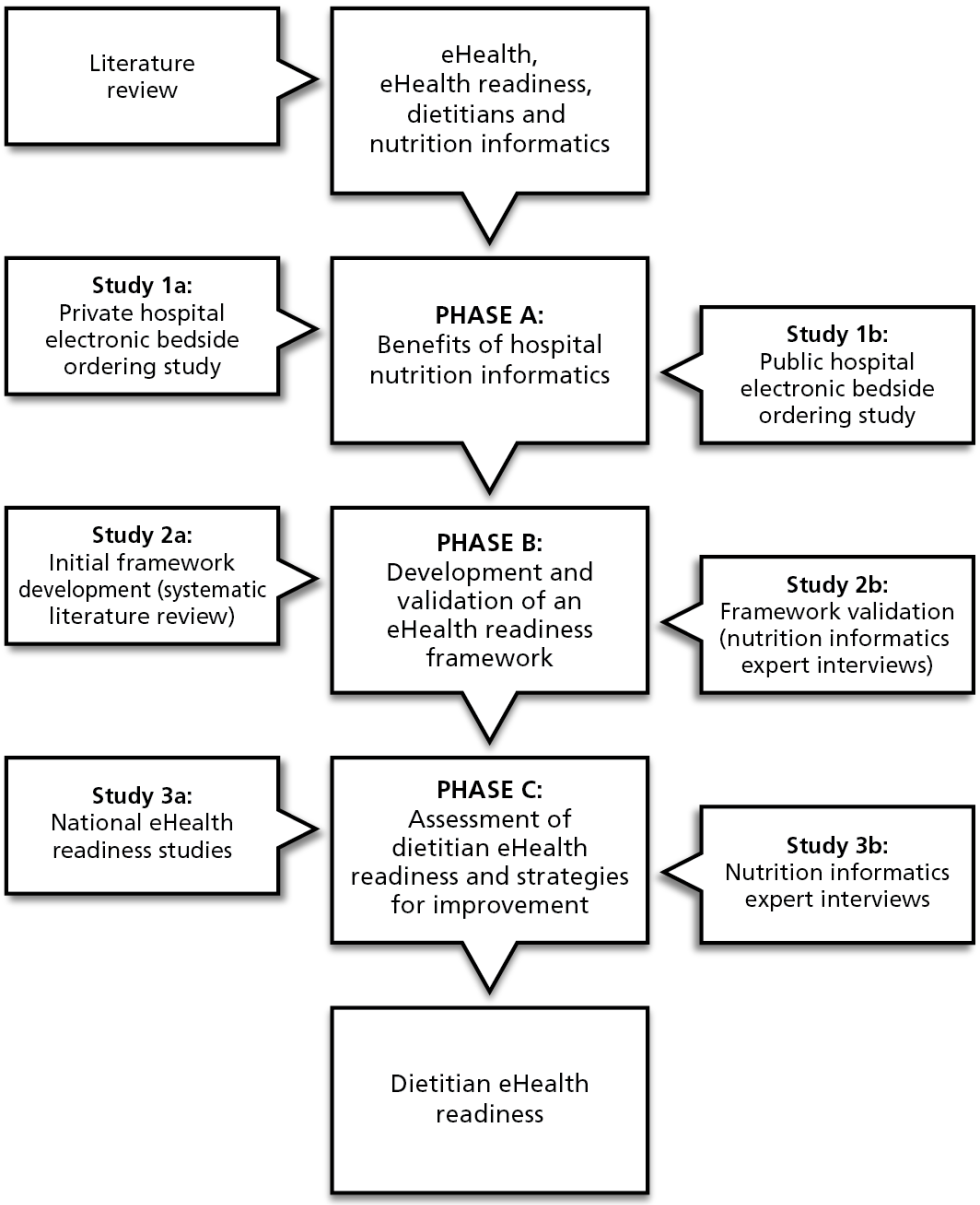


Figure 1.6: Flow diagram of the research plan.

1.7 Structure of the thesis

This thesis reports six key studies (Figure 1.6) discussed in seven chapters:

Chapter 1: Introduction

This chapter provided a brief background to the research, describes the position of the researcher (and origin of the research), outlines the aims and objectives/research

questions, and summarises the thesis structure. This introduction seeks to summarise eHealth (benefits, drivers, and risks), and eHealth readiness within Australian healthcare. As this study focuses on eHealth readiness by dietitians, this chapter also introduces the profession of dietetics and provides an overview of nutrition informatics and the current use of eHealth by dietitians. Also discussed is the practice area of hospital dietetics, specifically foodservices, as this will be the focus area for the research studies.

Chapter 2: Methodology

This chapter is devoted to a detailed description of the research framework and methodology adopted to address each of the research objectives. The research methodology employed a three phase mixed methods approach, utilising both quantitative and qualitative research methods, to conduct the six research studies.

Chapter 3: Hospital electronic bedside ordering studies

Phase A: Studies 1a and 1b

Due to the paucity of research data relating to the benefits of nutrition-related eHealth systems within the hospital environment, two quasi-experimental pre-test post-test cohort studies were conducted – the first in a private hospital and the second in a public hospital. These studies demonstrated the potential benefits to be achieved through replacing a paper menu with an electronic bedside menu ordering system in relation to improved patient nutritional intake.

Chapter 4: Development of an eHealth readiness framework

Phase B: Studies 2a and 2b

The results of a SLR to identify eHealth readiness frameworks, assessment models and themes, followed by the development and validation of an eHealth readiness framework for dietitians through semi-structured interviews, was the focus of chapter 6. The purpose was to create a framework that could be utilised to guide the

assessment and reporting on the eHealth readiness of dietitians in Australia, including the results of the national eHealth readiness surveys.

Chapter 5: National dietitian eHealth readiness study

Phase C: study 3a

The findings reported in this chapter provide a cross-sectional analyses of two national surveys on eHealth readiness, reporting on demographics, educational support preferences, current eHealth usage, and eHealth readiness across four domains: access, attitude, aptitude, and advocacy. In addition, this chapter provides a comparison of eHealth readiness of Australian dietitians compared to their US colleagues. This provides the context for study 3b, as well as critical baseline measurements for future studies on eHealth readiness by dietitians in Australia, and dietitian preferences for future CPD activities.

Chapter 6: Nutrition informatics expert interviews

Phase C: Study 3b

This chapter outlines the results of interviews with nutrition informatics experts, which investigated the reasons why dietitians in Australia may not be leading eHealth initiatives. The insight provided by these experts is pertinent to inform future CPD directions, but also information relevant to Australia's national eHealth agenda which seeks to increase the utilisation of eHealth across the health sector.

Chapter 7: Conclusion and future directions

The concluding chapter summarises the research findings, limitations, significance and implications for future research and practice. Whilst it represents the conclusion of this study, it also introduces opportunities for continued research in relation to dietitian and other allied health professional eHealth readiness.

CHAPTER 2: METHODOLOGY

2.1 Introduction

This chapter is devoted to a detailed description of the research framework and methodology adopted to address the research aim: to examine the benefits of nutrition informatics in hospitals and to critically evaluate the readiness of dietitians for eHealth – *Are dietitians ripe for disruption?* As this is a broad aim, six research studies were conducted in a three phase approach (reported in Chapters 3-6), as displayed in Figure 1.6. A mixed methods approach was employed, concurrently utilising both quantitative and qualitative research adopting both deductive and inductive approaches.

The research was divided into three phases in order to answer the five research objectives, and ensure a complete examination of the research question:

1. Exploring the potential benefits of nutrition informatics;
2. Development and validation of an eHealth readiness framework; and
3. Assessment of dietitian eHealth readiness and strategies for improvement.

This chapter outlines the position of the researcher (written in first person); a description of quantitative and qualitative research methods in healthcare, outlining the premise of both approaches within this research; a detailed methodological description and justification for each of the phases; and a summary of the research methodological design.

2.2 Quantitative and qualitative research methods in healthcare

As the complexity and diversity of health services provision increases so too does health services research. Healthcare research has a strong predilection for quantitative research. The National Health and Research Council (NHMRC) levels of evidence hierarchy according to the research design, which rates the systematic

review of randomised control trials (RCT) as the highest level of evidence and qualitative research methods as the lowest.[176] However, whilst quantitative research may be the 'gold standard' from the clinical research paradigm, there are difficulties in terms of feasibility and application in healthcare, as well as limitations when the research questions include the organisation and culture.[177] Consequently, the role of qualitative research in healthcare research is increasing, and the use of a combination of quantitative and qualitative (mixed methods approach) can be complementary and provide a more holistic view of the research topic.[178] Within each of the three phases of the current research, a mixed methods approach was adopted aiming to minimise the disadvantages of single methodologies, enrich the study design, and provide a more comprehensive exploration of each topic.

Research thinking and action processes represent different ways of reasoning that distinguish between quantitative and qualitative research.[179] Theories can be developed through deductive or inductive reasoning. Deductive reasoning is usually associated with quantitative research, and involves formally testing a theory against a specific case/s in a quantitative manner.[179] Based on a theory and its propositions, a hypothesis is derived and formally tested through experimental studies.[179, 180] Inductive reasoning in contrast allows for the qualitative data to generate, rather than test, the theory.[179] This type of reasoning works from observations or propositions around a phenomenon.[156] However, whilst theoretically these approaches are aligned with a quantitative or qualitative approach, in health services research in particular there is not necessarily a one to one correspondence between epistemology and methods.[177]

2.2.1 Ensuring accurate and rigorous data collection and analysis in qualitative research

Just as in quantitative research, rigorous and transparent techniques are also essential in qualitative research. To enhance accuracy and rigor during data collection and

analysis, strategies such as triangulation,[179, 180] reflexivity,[179, 181] credibility,[182] authenticity,[182] saturation,[179] and integrity were adopted.[182]

'Triangulation is a methodological approach that contributes to the validity of research results when multiple methods, sources, theories, and/or investigators are employed.'[183] In 1978, Denzin defined four types of triangulation techniques: methodological (involves using more than one research method, such as interviews and questionnaires); data (involves the use of multiple data sources, such as respondent groups); theoretical (involves using more than one theoretical scheme to interpret the research findings); and investigator (involves using multiple researchers in the investigations).[184] The overall aim of triangulation is to develop a comprehensive understanding of phenomena.[180]

Multiple triangulation techniques were incorporated into the study design through the adoption of a mixed-methods and process approach, the use of a variety of data sources and respondent groups and a variety of investigators, to enhance the comprehensiveness of this research and to overcome research bias. The incorporation of triangulation into each phase of the research also enabled the integration of the results at the interpretation stage of the analysis.[183] The design of three distinct research phases integrated to inform the PhD is also a form of triangulation.

Reflexivity is the self-conscious awareness by the researcher of their position in the research process, which was addressed through a clear statement of previous experience and background (Section 2.3), and an examination of investigator perspectives and personal biases throughout the research.[179, 181] The credibility of the research is enhanced by a variety of sampling and recruitment strategies, providing a clear and transparent description of the data analysis, and involving a second review of the transcripts and second coder of topics and themes.[182] The research authenticity should be supported by digital recordings of the interviews, and the illustration of key points through exemplar quotes, ideally independently identified before

discussion and consensus.[182] Saturation refers to the point at which sufficient information (no new insights or findings) has been collected from the research, and can be identified through a data saturation graph.[179] The integrity was assured by obtaining ethics approval for each study and ensuring participant information sheets and consent forms were provided (Section 2.4).

2.3 The position of the researcher (and origin of the research)

Due to the qualitative methodology adopted for components of the research, it is important the position of the researcher is acknowledged and discussed. The idea for this research began to develop soon after graduating as a dietitian. This idea continued to grow over my 20 years of dietetic practice (including clinical, foodservices, project management, quality management and HIT), becoming an ever increasing area of interest, and both a professional and personal passion.

As a new graduate clinical dietitian working in a large teaching hospital, I also worked as the allied health representative for the development of clinical pathways – a ground-breaking opportunity to standardise and streamline processes for the management of common patient diagnoses across the entire healthcare team. However, despite the demonstrated benefits to staff and patients, without the support of IT, the key objectives could not be met and the project could not be sustained. As my career advanced it continued to move into the field of informatics (although I did not know that is what it was called at the time). Since employed at CBORD as a software implementation manager I was actively involved in over 45 hospital foodservice transitions from manual paper based systems to electronic management solutions. During this time, I repeatedly witnessed benefits being achieved of a type and magnitude not realised or captured by the staff responsible for implementing and using the system.

As the years progressed, I also observed nutrition-related IT initiatives being driven not by dietitians (the nutrition experts), but by other departments with primarily a

cost-saving and efficiency driven agenda. After 15 years of experience working and collaborating with hospital staff (such as clinical and foodservice dietitians, foodservice managers, chief information officers and other IT staff), I had a clear first hand understanding of the complexity of the hospital nutrition and foodservice environment, as well as managing significant change projects. With an appreciation of the challenges, I could no longer allow the opportunity for dietitians to drive IT initiatives to meet their practice requirements to be missed, and the potential benefits from being achieved, and so my research journey began.

Therefore, with experience working in nutrition informatics, and a commitment to conduct research, advice from Professor Peter Williams guided me towards developing my research skills through a Graduate Certificate in Advanced Dietetics. During this time, my initial thoughts of sharing the potential benefits of eHealth quickly became a reality, through a pilot research study (which lay the foundation and justification to pursue further research relating to BMOS).[152] This information also reinforced my initial thoughts that it was crucial dietitians were not only aware, but needed to be equipped to accept and utilise technology, as well as take the driver's seat in driving nutrition-related HIT solutions. It was not going to be an option any more, IT was the present (not the future) disrupting all areas of life, and we needed to be prepared.

With years of practical experience, passion and enthusiasm in-hand, I embarked on the journey from Graduate Certificate to PhD, building my research skills with the essentials required to complete this journey. During this time I achieved the CHIA, encouraging other dietitians working in health informatics to obtain this credential also, aiming to strengthen our eHealth capacity and skills as a professional group.

My passion to demonstrate and share the potential benefits of nutrition informatics to patients' nutrition outcomes, and fear of the risks of our profession not being adequately engaged, made this PhD enjoyable and exciting from start to 'finish' (as

the work will continue). Whilst declaring my personal experience and potential bias, maintaining objectivity was always considered important throughout the research, and strengthened through critical reflexivity of the researcher, involvement of four experienced supervisors, adoption of methodology to minimise bias and submitting the studies for publication in peer-reviewed journals.

2.4 Ethical considerations

Ethics is a critical component of the research design process. Human Research Ethics Committee approval is required for all research studies involving humans to protect the human participants and ensure research integrity.[182] The primary values of research ethics are based on respect for human beings, research merit and integrity, justice, and beneficence.[185] Respect for the participants involves ensuring informed consent and protecting their privacy and anonymity.

Study participants should be provided with information sheets and consent forms, outlining the study details and what the role of the participant would encompass. This information should include sufficient information to ensure an adequate understanding of the purpose, methods, demands, risks, potential benefits of the research and the planned dissemination of the research results.[185] Participants should also be made aware of their ability to refuse participation or withdraw their consent at any time, without any consequences.[185] When recording data, analysing transcripts or observational data, the researcher must ensure no identifying information is revealed and participant anonymity is maintained. The use of coding rather than recording names or other personal information that may reveal the subject's identity will ensure privacy and anonymity. Ethics approval was obtained for each of the research studies within this thesis.

2.5 Phase A: Benefits of nutrition informatics

2.5.1 Introduction

In order to warrant an examination of dietitian eHealth readiness, it is firstly important to identify: are there benefits of nutrition informatics (eHealth), which consequently confirm its relevance for dietitians? This must necessarily include a broad view of the individuals, communities and groups seeking care (satisfaction and health outcomes) and other stakeholders (professionals involved in care and the financial impact). In the context of the current research, the benefits of nutrition informatics in hospitals was chosen as the area to focus this analysis due to the potential to achieve significant patient nutrition outcomes, as outlined in Section 1.4.1. In summary, the hospital environment is the most common primary practice area of dietitians, providing an opportunity to impact a large number of patients specifically in relation to malnutrition (a key issue of nutrition concern), and is the initial target area for the government eHealth agenda (with the introduction of the EHR).

Therefore, to identify and demonstrate the benefits of hospital nutrition informatics, the first objective of this research was investigated: *To demonstrate the potential benefits of nutrition informatics in hospitals, by replacing a patient paper menu system with an electronic bedside menu ordering system (BMOS) in the hospital environment.* The details and outcomes of this research are reported in Chapter 3.

2.5.2 Design

Whilst the primary goal of eHealth is to improve the quality of healthcare provided to the patient, the benefits must be considered within the context of the entire organisation.[52] A nutrition eHealth solution can impact various levels of an organisation and therefore need to be taken into consideration when assessing the benefits, such as the department/s, staff, patient and the patients' nutrition care. In addition, measuring the impact of a particular HIT implementation requires the identification and consistent application of reliable indicators (such as changes in

patient outcomes), measures and tools.[186] The BMOS studies identified in the literature review (reported in Section 1.4.3) utilised different indicators, measures and tools. Consequently, there was no consistent or clearly demonstrated framework to adopt to guide this research, or to enhance and contribute to the existing literature.

The intention of this study was to identify and capture as many relevant key indicators to measure to determine the benefits of an eHealth implementation, to ensure a comprehensive analysis without bias for one particular outcome. Therefore, in the absence of a comprehensive guide, a framework by Canada Health Infoway (2013) (based on the Delone and McLean IS Success Model),[187] was utilised to guide this process, breaking down the outcomes into three areas: quality, access and productivity (Figure 2.1).[188] Similar frameworks have been reported in the eHealth literature,[52] including authors Scott and Saeed (2008) who listed acceptability, in addition to these three areas.[186]

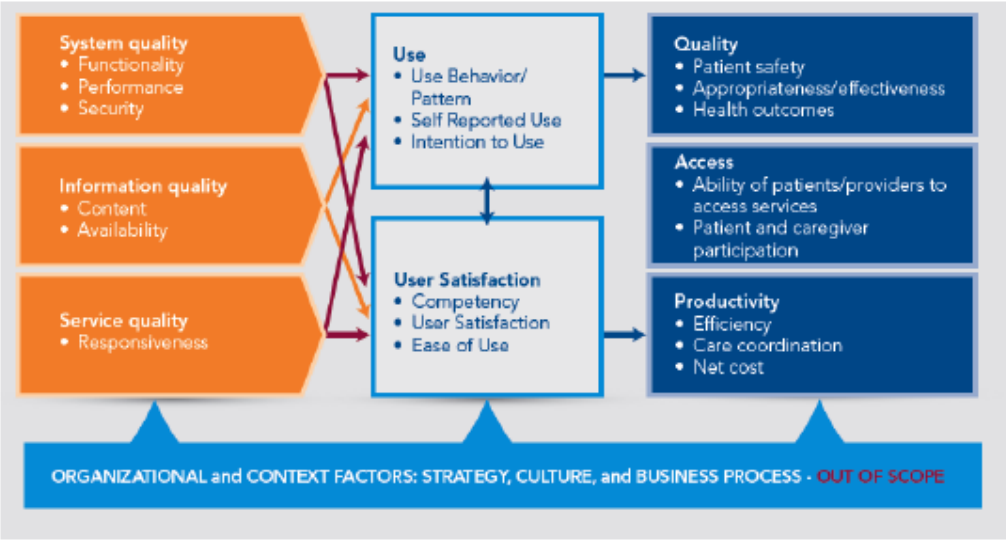


Figure 2.1: Infoway Benefits Evaluation Framework[188]

The studies identified in the literature outlined a variety of indicators used to assess the outcomes of a BMOS implementation, and therefore also assisted in determining the key variables to measure for this research ensuring coverage of all of the framework areas.[128-130, 132, 151, 152, 173-175] The indicators (and measures) selected as part of this research included:

- Quality: Patient nutrition care (nutritional intake), patient nutrition goals achieved (nutritional intake compared to individual energy and protein requirements) (representing both *effectiveness* and *health outcomes*).
- Access/acceptability: Patient engagement (representing *participation*) (NA time spent directly with patients), patient acceptance (patient satisfaction), staff (NA) acceptance (staff satisfaction).
- Productivity: *Efficiency* (human resource requirements)

Cost and accuracy were the only identified indicators not included in this study, as they could be linked to existing outcomes and had been previously demonstrated in other BMOS studies, and in consideration of managing the scope of this research. A cost analysis completed during a pilot study demonstrated the electronic solution was cheaper,[152] and can reduce meal and labour costs.[128, 129] Improvements in efficiency were demonstrated through the reduction in production hours,[130] reduced late and wasted trays,[129] and reduced staff requirements (for trayline and diet office tasks),[130] which consequently also contributes to cost savings. Meal tray accuracy was increased with BMOS.[128, 174]

Only four of the nine BMOS studies identified in the literature review (reported in Section 1.4.3) defined the study design, which included an observational trend, pre-experimental, retrospective and pre- post-test study. The paucity of research, as well as the lack of robust studies, demonstrates a gap in the research and highlights the complexity of hospital foodservice research. The study design would need to be determined based on the aim to strengthen the evidence; in consideration of the live

hospital environment; and in consideration of the quantity of indicators selected for measure, which will be labour and time intensive.

According to the NHMRC, the second highest level of evidence would be obtained using a RCT, which provides the best source of evidence for effects of interventions.[176] Randomisation minimises biases that may occur when individuals are openly allocated to the intervention or control groups, and other factors that may influence the clinical outcome being studied.[176] However, as the study was conducted in a real hospital environment during a significant change in dietetic and foodservice operations as a result of a new information system rollout, it would not have been feasible to conduct a RCT in this environment without major staff and financial implications, as well as the potential to significantly affect patient service delivery and potentially satisfaction. A change of this scale affects the entire hospital, from the dietetic and foodservice departments to nursing and administrative staff, to the patient and is required to occur on a schedule outside the control of the PhD student. The implementation and timeline are controlled and limited by hospital staff and financial resources.

A quasi-experimental pre-test post-test cohort design enables research outcomes to be measured before and after the intervention for comparison, where the pre-test data serves as the 'control' period.[189, 190] This study design is superior to the one-group post-test design, as without any pre-test observations (or a control group) there are multiple threats to internal validity.[165] The one-group post-test design is often the methodology adopted in eHealth research relating to the implementation of new software, due to the difficulty in getting pre-test measurements in healthcare due to time, technical and cost restraints.[165] Therefore, the pre-test post-test study design was selected as the most comprehensive study possible in the real hospital environment with the resources available to hospital foodservices department and PhD student, which would gather all the required indicators, and have the least impact on the staff and implementation. To increase the confidence in attributing any

changes from the introduction of a BMOS, the study was repeated across two facilities in different states with different menus; the first in a private hospital (study 1a) and the second in a public hospital (study 1b). The same tools and processes would be implemented for both studies, and no other variables within the foodservice departments would change.

2.5.3 Assessing nutritional intake

The importance of food (nutritional) intake in hospital was outlined in Sections 1.3.3 and 1.4.2, and consequently the measurement and analysis of nutritional intake for hospital patients was considered one of the key indicators to measure. However, the assessment should encompass not just the amount of food consumed, but also details of what was consumed, to enable the complete nutritional analysis to be determined. This data provides a clear picture of overall nutritional intake at a patient level, and enables a comparison of patient intake compared to their individual nutritional requirements, which corresponds to nutrition (malnutrition) risk.[93] It also provides an overall picture of the foodservice menu, patient preferences, and intake trends across meal periods.

Accurately measuring dietary intake in hospital patients is complex and can be conducted in a variety of ways in clinical practice and research. The most comprehensive, but on a large scale not a practical method, is weighing the individual meal items before and after the patient meals are delivered and consumed, allowing for exact nutrient analysis comparisons.[191-193] In a hospital foodservice environment, it is not only time and resource intensive, but would present difficulties logistically, disrupting and delaying processes that are time critical.[194] The method used most extensively in the scientific literature is visual estimations, and has been cited as a good method of validating other intake assessment methods.[194] Some utilise the menu as the record of selections and through a visual assessment of the food left on the tray after each meal, determine the overall waste.[195] More commonly is the utilisation of the ‘24-hour diet observation/recall’ tool used in the Australasian

Nutrition Care Day Survey[27] and other large cohorts studies, which records 0%, 25%, 50%, 75% and 100% plate consumption.[98, 196, 197] Whilst visual estimates introduce potential problems of subjectivity and the inter-observer reliability, they have been validated against weighted waste and determined to provide reasonable approximations.[193]

Advancing technology has enabled digital photography of plates pre- and post-consumption to become a more common method for the collection and recording of meal intake data.[194] Whilst this method is similar to the visual estimation process, it enables rapid acquisition of data in the eating environment, which is more convenient to participants and researchers, and also allows for an unhurried evaluation of the intake external to the eating environment. This methodology was compared to weighted meal trays by Williamson et al (2003), and validated as a method for measuring food intake and plate waste.[194] However, to ensure all of the required intake data was captured, two approaches were adopted for these studies, firstly a simplified version of the '24-hour diet observation/recall' tool was used to record an estimation of food intake of each meal item and the overall tray. Secondly, each meal tray was photographed before delivery and after consumption, to allow for comprehensive nutritional analysis of each meal item to be conducted.

The analysis of patient nutritional intake data is performed using a nutrient database, either paper based or electronic, which allows each menu item and recipe to be individually analysed for nutrition breakdown resulting in an overall total of nutrient analysis per patient per meal and day. Within a healthcare facility, using the system they utilised to setup and analyse their menu items and recipes (if that is available), would allow for the most efficient and accurate means to analyse the intake data. If there was not a current system, all of the menu items and recipes would need to be analysed for a nutritional breakdown for energy and protein. For this research, the hospitals utilised an electronic food and nutrition system (CBORD® Food and Nutrition solutions (FNS)),[198] which contained the AusNut Special Edition (1999)

nutrient database[199], and the nutritional analysis of the specific hospital menu items and recipes. Whilst there are newer versions of AusNut that provide additional macronutrients, this study was analysing energy and protein, and therefore the existing nutrient database was suitable.

Convenience or 'opportunistic' sampling involves the recruitment of available subjects within the available timeframe of two separate 48 hour periods.[179] This method was adopted to ensure the greatest number of potential participants, and as probability sampling (such as random sampling) would not be possible with the introduction of an electronic system in a real hospital environment where all patients would need to be included in the solution.

2.5.4 Estimating energy and protein requirements

In the hospital setting, accurately estimating energy requirements of patients is required for optimising nutrition therapy, and for preventing under- or over-nutrition. Identifying adequate (or inadequate) patient nutritional intake involves comparing patient nutritional intake to their individual energy and protein requirements. This provides a comprehensive understanding of the nutritional intake status of the patients, and consequently level of malnutrition risk on a per patient basis, versus just nutritional intake alone.

There are multiple methods to determine estimated energy and protein requirements of hospital inpatients. Whilst direct calorimetry is the most accurate method for measuring energy requirements, indirect calorimetry (which might be viable in a hospital setting), requires expensive equipment, trained personnel, significant time and for the patient to be ambulatory to be tested, and therefore is impractical for research on large patient numbers in the clinical setting.[200-203] Therefore, predictive equations are utilised to estimate energy requirements for patients in the clinical setting for the purpose of nutrition care and research. There are numerous predictive equations utilised in the clinical and research setting, however few have been

validated for a heterogeneous group of adult patients.[204] Most predictive equations have been developed either on healthy subjects, or for specific gender, age, or BMI groups.[204] Consequently, the existence of over- and under-estimating with predictive equations in the hospital setting with mixed subjects, must be acknowledged as a limitation of this analysis.[200-202, 204]

Of the predictive equations available for estimating energy requirements, the Schofield equation was selected for three key reasons. In the research study settings, the Schofield equation was the tool being utilised by the dietitians, and the patient heights are not a standard measurement collected in these study settings.[205] In addition, this equation is one of most commonly used in the Australian setting, and was used in the development of the Nutrient Reference Values for Australians.[206] To counter the tendency of the Schofield equation to overestimate energy requirements,[203, 207] the activity factor of 1.2 (bed-rest) was applied to the calculations.[205]

Estimating dietary protein requirements of hospital patients is also important, as it supplies amino acids essential for the synthesis and maintenance of body proteins (which make up structures of muscles and organs), as well as fulfil a wide variety of other essential functions inteh body.[208] Similarly to predicted energy requirements, predicting protein requirements is difficult, and altered by illness, metabolic changes based on disease state, as well as by reduced activity.[208] Many of the published protein requirements are provided as a range, for example 1.0 – 1.5g/kg, and for the purpose of research on a population need to be defined based on most commonly reported value and the severity of the hospital population within each disease state. For the purpose of this research, the estimated protein requirements were based on 1g/kg for all patients who were in the general medical or rehabilitation classification,[208-211] 1.1g/kg for minor surgical patients[187-212] and 1.2g/kg for oncology patients.[208, 210, 211, 213]

2.5.5 Measuring patient satisfaction

A crucial indicator when considering the success of a hospital foodservice operation is patient satisfaction. As outlined in Section 1.4.2, patient satisfaction with foodservice has been linked to the overall hospital experience and satisfaction,[140, 141] as well as nutritional intake.[165] However, measuring patient hospital foodservices satisfaction is a complex, multidimensional construct which includes technical, environmental and interpersonal factors.[162] This is due to the role of hospital foodservice, which extends beyond the delivery of meals (or nutrients) to patients; it also provides an opportunity for patient choice, control, as well as connectedness and comfort.[214] In addition, patient satisfaction is subjective and difficult to measure, influenced by personal feelings and taste for example, so varies from patient to patient.[215] Despite these challenges, patient satisfaction is an important component to the success of a solution and is correlated with not just overall hospital experience and satisfaction[163, 164] but also nutritional intake,[165] as outlined in section 1.4.2.

Surveys in the form of questionnaires are typically adopted over qualitative methods, as the most efficient technique to capture the views of a large patient group.[8] They were adopted in this research since the key aim was to measure two variables: (1) overall general foodservices satisfaction, and (2) satisfaction and preference specifically regarding the meal ordering service. Questionnaires are written instruments utilised in quantitative research designed to elicit information from the subjects about a particular topic the researcher is investigating.[216] Ensuring reliability and validity are important considerations in quantitative research when utilising an instrument, such as questionnaires. Reliability is an important pre-measure of validity, as it refers to the ability of the instrument to produce consistent results.[8] Validity is the extent to which an instrument measures what it is intended to measure.[8]

Test re-test can provide a level of analysis of the reliability of the questionnaire, or its ability to provide a consistent result when completed by the same person on two

separate occasions under similar conditions.[8] The types of validity include: face, content, criterion and construct validity. Face validity refers to whether at face value the questions appear to measure the construct.[8] Ensuring all aspects of the construct are measured is content validity.[8] Criterion validity results are consistent with those from an established measure of the same construct. Finally, how well a questionnaire measures what is claims to be measuring, refers to construct validity.[217]

In the selection or development of a questionnaire, an initial literature review to ensure all aspects of the construct are included as measures, followed by some testing or focus groups with experts on the topic. Conducting a pilot study can be adopted as a method of testing reliability and validity. Criterion is important for questionnaire tools that provide a total score and are used for predicting current or future behaviour (such as a mental health screening tool), and construct validity is most important when developing an alternate questionnaire to one already in existence.

Common hospital-wide patient surveys, such as PressGaney,[218] only incorporate a small number of general questions about nutrition and foodservices, which are not sufficient to provide feedback on all of the influencing factors. Consequently the most widely used and comprehensive questionnaire identified in the literature, the reliable and validated Foodservice Patient Satisfaction Survey,[214] was utilised to gather patient demographic data and measure general foodservice satisfaction.

The Foodservice Patient Satisfaction Survey only includes one question about the meal ordering service ('I am asked about my food and drink preferences'). This is mostly likely due to the substantial advancements in hospital foodservices over the last decade, including the transformation from the historical manual paper menu and set meal time deliveries to electronic solutions offering a diverse opportunity for a variety of patient-directed meal ordering and delivery solutions. As there were no other surveys for this purpose identified in the literature, a specifically designed Meal

Selections Survey was developed to assess patient satisfaction with the meal ordering service and about their interaction with the NA. To ensure the development of an accurate survey, a literature review was conducted, dietitian experts in foodservices were engaged to ensure content and face validity, and pilot testing was conducted. Further details of this process are outlined in Chapter 3.

The same sampled population of patients for assessing nutritional intake were also provided with the invitation to participate in the patient satisfaction component of the research.

2.5.6 Measuring NA satisfaction and time with patients

NA satisfaction is another important indicator to measure, as they are the staff primarily interacting with the BMOS solution and directly with patients. Their role (as outlined in Section 1.4.2) is central to hospital foodservice meal delivery, and studies have demonstrated that staff engaging with patients regarding their meal ordering can significantly increase overall patient satisfaction with foodservices.[167, 137, 169]

There were no existing surveys available in the literature for the particular purpose of determining NA satisfaction pre- and post- implementation of a change in service delivery model – specifically that of a BMOS. Therefore, a survey was developed to determine their preferred service model, and to assess if there were changes in the utilisation of their nutrition knowledge; patients' awareness of the NA role; and the level of menu selection assistance provided to patients. The survey was tested for face and content validity by four dietitians and three NAs. The survey was modified based on the initial feedback received, which included several word modifications, and it was re-tested once more as the dietitians and NAs then reached a consensus. The survey was pilot tested during a pilot study at the Private hospital with patients, and no changes were required.[152] Due to the small numbers at both hospitals, all of NA staff were invited to participate in the survey.

The time spent face-to-face with patients was an important indicator in this study, as a measure to determine patient engagement and participation in the meal ordering process. As noted in Sections 1.2.3 and 1.4.1 patient engagement in their health choices has the ability to improve their satisfaction and ultimately improved health outcomes, due to a feeling of control and involvement. Given the pre-test model of meal ordering involved a paper menu being delivered and collected from the patient room and without patient interaction necessarily, and the post-test model of meal ordering required patient engagement, this was an important outcome to measure. It could also provide valuable data when considering efficiencies, comparing whether the different ordering systems took the same or different amounts of time, and where that time was being spent.

Time study is the method used to measure the time interval of a repetitive work task through a direct and continuous observation of that task, using a timekeeping device to record the time taken to complete the specific task.[219] A time interval is defined as the elapsed time between two events.[220] There are various timekeeping tools, such as a digital decimal minute stopwatch, analogue mechanical stopwatch or a videotape camera, which are utilised to complete the time-keeping log for each task recorded.[219-220] The mobile phone stopwatch was adopted for the time study of NAs direct patient interaction, as every researcher had a mobile phone, and they could easily be calibrated through direct comparison without needing test equipment.[220] The time interval was defined as commencing on the NA greeting the patient, and ending as the NA leaves the patient bedside. A limitation of the stopwatch for time recording and calibration is the operator's start/stop reaction time, which can contribute to the time, especially for short time intervals.[220] However, videotaping every NA interaction with patients was not feasible due to requiring an additional researcher, and additional time to analyse all of the recordings. In addition, the analysis would require a researcher to manually identify the start and stop time for each time interval, which could have the same limitations as the stopwatch process.

2.6 Phase B: Development and validation of an eHealth readiness framework

2.6.1 Introduction

With the demonstrated benefits of nutrition informatics, and the knowledge that eHealth readiness of a healthcare professional has been demonstrated to reduce the risk of implementation failure (as outlined in Section 1.2.6), an examination of dietitian eHealth readiness is warranted. Without any commonly known or utilised frameworks or tools to comprehensively assess a healthcare professionals' readiness, information on eHealth readiness is reliant on dietitian opinion. Therefore, in order to thoroughly investigate dietitian eHealth readiness, an understanding of what this encompasses needed to be quantified. Consequently, the second objective of this research was: *To develop and validate a framework to assess the eHealth readiness of dietitians*. The details and outcomes of this research are reported in Chapter 4.

2.6.2 Design

The intention of this study was to create an eHealth readiness assessment framework that could be utilised by dietitians to guide the selection or development of assessment models to determine readiness on an individual level, as a professional body or for specific eHealth implementations, ensuring all aspects of readiness are considered. As there are no guidelines for the development of frameworks, the methodology employed was a phased approach, with the results of each phase contributing to the methodological design of the following phase.

This study was divided into two key stages: a SLR to identify themes for determining the eHealth readiness relevant to dietitians, and data synthesis to extract relevant eHealth readiness themes to develop a draft framework. The second stage consisted of semi-structured interviews with Australian nutrition informatics experts to gain consensus and validate the framework (Chapter 4).

2.6.3 Framework development

A SLR is a method to identify relevant studies with eHealth readiness frameworks, assessment models or themes , appraise the quality and summarise the results, using an explicit and scientific methodology.[221] They are distinguished from traditional reviews and commentaries through the adoption of the explicit and scientific (systematic) approach.[222] A SLR was selected for the first phase of this research based on the four reasons cited by DePoy et al (2005) for using this methodology:

1. *Determine if there is previous research on the topic of interest*
   To determine if there are any existing frameworks, assessment models, or themes of eHealth readiness.

2. *Determine the level of theory and knowledge development*
   To determine if the information would contribute to the development of a framework.

3. *Determine the relevance of the current knowledge base to the problem area*
   To determine if the research findings would be relevant for dietitians.

4. *Provide a rationale for the selection of the research strategy*
   To identify the research designs employed across the literature for framework development in relation to eHealth which could guide the rest of this research study.[179]

The SLR search protocol was conducted according to PRISMA statement[171] and reported using a narrative synthesis. Following the summary of results from the literature review, data analysis was conducted to identify eHealth readiness themes applicable to dietitians and develop a draft framework. As the purpose of the SLR was to identify relevant eHealth readiness themes for consideration for the framework development, each study was not critically appraised for the purpose of comparison or quality. The identified themes may be applicable to other allied health

professionals, however for the purpose of this research, the scope was limited to dietitians.

2.6.4 Framework validation

Methods to gain input and validate a tool, process or framework can be achieved through engaging experts within the specific field, through surveys (in the form of a standard questionnaire or Delphi study), focus groups or interviews. Surveys are utilised to capture quantitative information on a large scale, such as measuring characteristics of a population.[179] Focus groups are a method to collect qualitative information by encouraging group interaction, rather than the researcher asking individuals questions.[8] This method encourages involvement from everyone, including those reluctant or feel they have nothing to contribute, and monitors the change in the group's opinions.[8] Interviews are another method to collect qualitative information, but conducted with one individual either face-to-face or over the telephone.[179] The primary purpose of an interview is to gain detailed information and perspectives, understandings and meanings by people regarding a particular topic, issue or event.[223]

Of the fourteen unique authors identified in the literature review for the identification of eHealth readiness themes or the development of various frameworks (first stage of this research), a mixture of these techniques were employed: surveys (5), Delphi study (1), focus group (1), and interviews (7), unspecified (2). Two authors adopted a combination of methods, one with interviews and focus groups, and the other with interviews and surveys. This study design would need to be determined based on the aim to provide a comprehensive framework validation, but also within the limitations of the small number of nutrition informatics 'experts' in Australia and the feasibility of gathering them all in one place at one time.

Whilst there is the potential of interview participants to feel uncomfortable in the one-to-one setting, responding in a way to please the interviewer (rather than report

their true opinions), it was selected over focus groups or questionnaires as the aim was to elicit individual thoughts and explore responses further as required. Focus groups may be influenced by a dominant view, and alternate views may be less accepted or possibly not externalised.[223] In addition, logistically gathering participants from a wide variety of geographically locations and from various practice areas in one location was not possible. Questionnaires have the potential to produce undifferentiated positive responses, and do not allow for the exploration of complex issues such as views and perceptions through discussions.[224]

Consequently, interviews were chosen as the best method to employ for the validation component of this study, due to being the most common method reported in the literature and the feasibility of conducting interviews across a wide variety of geographical locations. Exploration of opinions from nutrition informatics experts was crucial to ensuring all dimensions related to eHealth readiness were captured, and for certifying framework validation. Semi-structured interviews were employed to identify attributes of eHealth readiness of dietitians as perceived by nutrition informatics experts, and to develop consensus and validate the framework.

Interview participants were invited to participate through a combination of purposive and snowball sampling. Purposeful or 'judgmental' sampling involves the deliberate recruitment of subjects by the researcher based on predefined criteria.[179] Snowball sampling or 'networking' involves asking subjects for referrals to others who may meet the study criteria.[179] This method enabled experts in the field of nutrition informatics to be targeted and additional subjects to be identified, and to ensure representation across a variety of dietetic practice areas.

2.7 Phase C: Assessment of dietitian eHealth readiness and strategies for improvement

2.7.1 Introduction

With the dimensions that encompass dietitian readiness identified and summarised in a framework, a thorough assessment of dietitian readiness can be conducted. Being able to assess dietitian readiness, and identify the areas for improvement will enable targeted strategies to prepare the profession adequately for eHealth.

This phase of the research encompassed the final three (third, fourth and fifth) research objectives:

- *To determine the eHealth readiness, and changes over time, of Australian dietitians.*
- *To identify the perceived barriers and enablers to dietitian eHealth readiness.*
- *To identify strategies to strengthen the capacity of dietitians to engage in eHealth initiatives and effectively drive successful nutrition-related eHealth implementations.*

The details and outcomes of this research are reported in Chapters 5 and 6.

2.7.2 Design

In order to address each of these research objectives, the final research phase would need to be conducted over a series of studies. The different research methodologies suitable for gathering this type of data include surveys, focus groups and interviews (defined in Section 2.5.5 and 2.6.4). A combination of surveys and interviews were adopted to complete this final phase most comprehensively.

A study using national surveys at two time intervals was designed to provide a cross-sectional analyses of the eHealth readiness of Australian dietitians, and identify perceived barriers and enablers to eHealth within the eHealth readiness framework context (Chapter 5, study 2a). The rationale for conducting the survey twice was to

provide more details than just a baseline study, identifying dietitian eHealth readiness, and enabling an insight into if and how quickly dietitian eHealth readiness status was changing over time.

Interviews with nutrition informatics experts were utilised to build on the findings of the national surveys and explore the final research objectives further (Chapter 6, study 2b). These interviews allowed for further exploration of the survey results on the barriers and enablers to dietitian eHealth readiness, as well as identification of strategies for the improvement of dietitian eHealth readiness.

2.7.3 Assessing dietitian eHealth readiness

Surveys in the form of questionnaires were adopted, rather than qualitative methods, as the only technique to capture a large representative sample of the Australian dietetic profession (of approximately 6,500), and to gather the quantity of data required for a comprehensive investigation of eHealth readiness. The benefits and limitations of surveys were outlined in the Phase A (section 2.5.5).

Whilst designing a new and original survey based on the eHealth readiness dimensions identified in Chapter 4 (within the developed Framework for eHealth Readiness of Dietitians (FeRD)), would be one approach to the creation of a survey, utilising an existing survey would allow for the benefit of previous pilot testing and confirmation of face and content validity. In addition, it would allow for a direct comparison with previous research, on the same topic. Therefore, to assess dietitian eHealth readiness in Australia and compare the results to the published 2011 Academy results (US dietitians),[147] the 2011 nutrition informatics survey developed by the Academy Nutrition Informatics Committee and HIMSS Analytics was chosen to be used. Some modifications were required to make it suitable for use in Australia, to improve interpretation by Australian dietitians, and to provide additional targeted research data. The limitation of this approach was the survey was not designed

specifically around the FeRD with thorough pilot testing on the Australian dietetic population, as would be the case if designing a new survey.

The initial survey was designed to capture a wide variety of opinions and broad representation of eHealth readiness of dietitians in Australia. While there may be other stakeholders relevant in this exploration, dietitians are best placed to provide the relevant insight required. The DAA has a database of all dietitian members and therefore this was a relevant source for distributing the survey invitation. Members of Dietitian Connection (a professional dietitian networking organisation) were also invited to participate to increase the number of potential participants. However, there would be dietitians in Australia who were not members of either organisation, and therefore would not have the opportunity to participate. Another limitation of this cross-sectional study and sampling method was that survey respondents may not be a true representative sample of the Australian dietetics population for the topic of eHealth, and may have some bias towards an interest in eHealth.

The FeRD, which encompasses five dimensions of eHealth readiness: access, standards, attitude, aptitude and advocacy (Figure 5.8 and 5.9), was utilised to analyse the survey questions. Each of the 30 questions were linked to the corresponding framework dimension.

2.7.4 Identifying strategies for improvement

In-depth semi-structured interviews were employed to build on the results of the national surveys. Exploration of opinions from nutrition informatics experts was conducted regarding the eHealth status of Australian dietitians; perceived barriers to eHealth; and to elicit individual thoughts and recommendations for preparing the dietetics profession for eHealth readiness. The benefits and limitations of interviews were outlined in the Phase B (section 2.6.5).

A purposive and snowball sampling technique was used to select participants with an expertise in the field of nutrition informatics and to ensure representation across a variety of practice areas. The selection of expert participants was based on meeting one of four main criteria: their experience with an eHealth implementation; research and publication on eHealth solutions for dietitians; role at a national level as an advocate for eHealth for allied health professionals; or being a CHIA.

2.8 Research methodological design summary

Whilst the evidence of benefits of HIT is established, the benefits specific to the dietetics profession, and within specific practice areas (such as food services) are yet to be clearly demonstrated. Consequently, this research commenced with a deductive reasoning approach, to verify the hypothesis that comparable benefits will be realised in the field of nutrition informatics (in hospital foodservices) as they do in the medical and nursing informatics field, in two experimental studies (Phase A – Chapter 3). Estimating daily energy and protein requirements, quantifying patient nutritional intake, work time recordings and surveys were the quantitative methods used in this research.

The development and validation of an eHealth readiness framework for dietitians, which did not previously exist, required a more inductive approach, using both qualitative and quantitative methodologies (Phase B – Chapter 4). The research involved several processes to develop and validate the framework, including a SLR (qualitative and quantitative), analysis and draft framework development (qualitative), and interviews with nutrition informatics experts (qualitative).

Following Phase B was a detailed investigation to understand dietitian eHealth readiness and identify potential strategies on how the profession can improve their readiness for eHealth (Phase C – Chapter 5 and 6). As no previous research or data was available on this topic, an inductive approach was utilised to gather data for analysis (using the eHealth readiness framework developed in Phase B). National

surveys were the quantitative methods used in these studies, and interviews were the qualitative methods used in this research providing an in-depth exploration of dietitians' opinions on how to improve the professions eHealth readiness. A summary of the research methodological design of this thesis is outlined in Table 2.1: including the research phases, studies, aims, data collection method, process and methodology.

Table 2.1: Research methodological design

Phase	Study	Objective/s (as per 1.6)	Data collection method	Methodology	Process
A: Benefits of hospital nutrition informatics	**1a:** Private hospital electronic bedside ordering study	1	Experimental	*Quantitative*	Deductive
	1b: Public hospital electronic bedside ordering study	1	Experimental	*Quantitative*	
B: Development and validation of an eHealth readiness framework	**2a:** Development of an eHealth readiness framework for allied health professionals	2	SLR and analysis	*Quantitative and qualitative*	Inductive
	2b: Validation of eHealth readiness framework for allied health professionals	2	Semi-structured interviews	*Qualitative*	
C: Assessment of dietitian eHealth readiness and strategies for improvement	**3a:** National nutrition informatics/ eHealth readiness surveys	3, 4	Observational studies – national surveys	*Quantitative*	Inductive
	3b: NI expert interviews regarding improving dietitian eHealth readiness	4, 5	Semi-structured interviews	*Qualitative*	

2.9 Chapter summary

A mixed methods approach was employed to address the broad research question in the complexity of the healthcare setting. Three distinct processes were adopted to specifically address each of the research questions and provide a comprehensive exploration of each topic and triangulation of the results. This chapter has outlined the research methodological design used to guide the research, and provided a rationale for the methods and designs adopted for each research phase. Chapters 3-6 provide further specific methods for each of the six studies undertaken as part of this thesis.

CHAPTER 3: HOSPITAL BEDSIDE ELECTRONIC MEAL ORDERING STUDIES

* The majority of Chapter 3, including the data related to the private hospital study has been published in a peer reviewed journal:
Maunder K, Walton K, Williams P, Ferguson M, Beck E. (2015) Energy and protein intake increases with an electronic bedside spoken meal ordering system compared to a paper menu in hospital patients. *Clinicial Nutrition ESPEN*, 10 (4):e134-e139.

* The data related to the public hospital study has been submitted for peer review:
McCray S, Maunder K, Moir J, Norris R & MacKenzie Shalders K. (2017) Bedside menu ordering system increases energy and protein intake while decreasing plate waste and meal cost in hospital patients. *Clinical Nutrition ESPEN*, 'revisions submitted'.

* The key findings of the private hospital study has been peer reviewed and presented at conferences and the abstracts included in the following publications:
Maunder K, Lazarus C, Williams P, Walton K, Ferguson M (2013). Patient nutritional intake increases with a Bedside Spoken Meal Ordering System. 30th National Conference of the Dietitians Association of Australia, Canberra. *Nutrition and Dietetics*, 70(Suppl.S1):16.
and
Maunder K, Williams P, & Lazarus C. (2012). Nutrition Care Benefits of a Bedside Spoken Meal Ordering System Compared to a Paper Menu. 16th International Congress of Dietetics, Sydney. *Nutrition and Dietetics*, 69 (Suppl.S1):136.

* The key findings of the public hospital study has been peer reviewed and presented at a conference and the abstract included in the following publications:
McCray S, Norris R, Maunder, K, Moir J, MacKenzie Shalders K. (2017). Bedside menu ordering system increases energy and protein intake in adult hospital patients. 34th National Conference of the Dietitians Association of Australia, Hobart. *Nutrition and Dietetics*, Vol 74 (Suppl. S1):34.

* The key findings from this chapter have been peer reviewed and presented at a conference and the abstract included in the following publications:
Maunder K, Walton K, Williams P, Ferguson M, Beck E. (2015). Food is medicine: utilising technology to enable collaborative decision-making for meal prescriptions for improving patient outcomes. (Poster). *Proceedings of the Health Informatics Society of Australia Health Informatics Conference*, Brisbane, Australia

3.1 Introduction

With the growing evidence demonstrating the benefits of eHealth on improving the quality of patient care; the launch of government eHealth initiatives; and the drive for enhanced patient engagement, HIT systems are imminent. However, the literature on the benefits of nutrition informatics to dietitians is scarce, particularly when focusing on the hospital foodservice setting. Whilst the evidence in the scientific literature specifically

on BMOS is limited (Table 1.1), the results demonstrate there are potential benefits over a manual paper based solution, and consequently support the need for further research study on this topic.

In the complex system of healthcare, a variety of factors influence dietary intake and consequently malnutrition status, however there is a paucity of literature on patient meal ordering as a potential strategy for improving patient nutritional intake. The introduction of a BMOS into hospitals offers an alternative to the traditional process of a paper menu. These new models enable patient meal selections to be collected at the bedside on handheld electronic devices with the assistance of a NA creating opportunities to increase patient and staff interaction, and engage patients in the meal ordering process. With the knowledge there are potential benefits of a BMOS, and that patients who have NA visit them or feel more involved display higher foodservice satisfaction,[169] a study to comprehensively investigate the role a change in foodservice delivered meal ordering (from a paper menu to BMOS) would be worthwhile.

3.1.1 Aim

The aim of these studies was:

To demonstrate the potential benefits of nutrition informatics in hospitals, by replacing a patient paper menu system with an electronic bedside menu ordering system in the hospital environment. (Objective 1)

The objectives of this study were to evaluate the impact a BMOS versus a paper menu on:

1. Patient nutritional intake (energy and protein consumption)
2. Patient satisfaction
3. The face-to-face time NAs spent with patients
4. NA satisfaction

3.2 Methods

A quasi-experimental pre-test post-test cohort study was conducted in a private hospital and repeated in a public hospital. The same tools and processes were implemented for both studies, and the same statistical analysis performed.

The foodservice and nutrition departments of both hospitals provide a cook-fresh menu and utilise the CBORD® FNS software[198] to manage all the foodservice and diet office operations. The NAs take menu selections for dinner the same day, and breakfast and lunch for the following day. During the paper menu phase the NAs delivered and collected personalised printed patient menus from the wards, and then entered the selections into the FNS in the diet office. In contrast, during the BMOS phase, the NAs visited all patients and discussed their menu selections at the bedside, entering them directly into FNS on a wireless mobile device. The BMOS enables access to all the available menu items for that meal and potentially more choices to be offered to the patient, compared to the printed personalised menus.

Patients who were on the maternity wards, critically ill or palliative, day stay (who would not receive a full 24 hours of meals), were nil by mouth, or restricted to fluids only, were excluded.

3.2.1 Private hospital

The first site was a 210-bed private hospital with an average length of stay of 6.0 days for the eligible study wards (which excluded Maternity and day stay patients). The prevalence of nutritionally at-risk patients was not routinely recorded, however the other hospitals within the organisation identified malnutrition prevalence by Subjective Global Assessment (SGA) as 42%.[99] The menu, recipes and food items offered to patients on a 7-day cycle did not change between the two study periods.

All patients admitted to the orthopaedic, orthopaedic rehabilitation, cardiology, oncology, general medical and gynaecology wards during the two weeks of data collection periods were eligible for inclusion. Baseline pre-implementation data were collected from eligible consenting participants in September 2011 whilst using the paper menu service (paper menu cohort). The BMOS was introduced in May 2012, and the post-implementation data were collected from eligible consenting participants in November 2012 (BMOS cohort). Data were collected by the primary researcher and five final year University dietetic students during a foodservice placement. The study proposal received ethics approval through the St. Vincent's Hospital Human Research Ethics Committee (11/119).

3.2.2 Public hospital

The second site was a 126-bed acute care public hospital with an average length of stay of 4.6 days for the eligible study wards (which excluded Maternity and day stay patients). The prevalence of nutritionally at-risk patients in 2016 was identified as 27%, during a one-day malnutrition prevalence audit. In contrast to the private hospital study, the menu, recipes and food items offered to patients on a 14-day cycle did change between the two study periods, with the organisation adding some more contemporary items. Both menus however, met the Queensland Health Nutrition standards[225] and Agency for Clinical Innovation standards for meals and menus.[226]

All patients admitted to the medical, surgical and oncology wards during the data collection periods were eligible for inclusion. Routinely collected quality assurance data were collected from eligible consenting participants in August 2014 whilst using the paper menu service (pre-test). The BMOS was introduced in December 2015, and the post-test data were collected from eligible consenting participants in August 2016 with the BMOS. Data were collected by four final year University dietetic students during a foodservice placement. The study proposal received an ethics exemption from the Mater Health Services Human Research Ethics Committee (EC00332).

3.2.3 Data collection processes and tools

The data collection processes and tools utilised were the same for both the paper menu and BMOS cohorts, and were similar across both hospital studies. Each main meal tray was photographed before delivery and after consumption, and in-between meal details were observed and recorded on paper. A simplified version of the '24-hour diet observation/recall' tool used in the Australasian Nutrition Care Day Survey[27] was used in addition to the photographic methodology in the private hospital study to estimate food intake over two 48 hour periods, encompassing all meals over four days of the seven day menu (Appendix A). Participants were visited after each main and mid meal by student dietitians and their meal consumption was recorded as 0, 25, 50, 75 or 100 percent of all the food served. After the completion of the first study in the private hospital, this was considered to not add any additional value to the photographic records, and just increased the data collection efforts, so was not repeated for the public hospital study.

The nutrition analysis was performed using FNS, which contains the AusNut Special Edition database,[199] and the nutritional analysis of the menu items and recipes. Based on the photographs and the observed intake data, the percentage consumed of each menu item was entered to obtain the energy and protein intake values (by item/recipe, meal and menu cycle day). The Schofield equation was utilised to calculate estimated individual patient energy requirements. The estimated individual protein requirements were based on 1g/kg for all patients who were general medical or rehabilitation,1.1g/kg for minor surgical patients, and 1.2g/kg for oncology patients.[209-213]

All consenting participants were provided with two surveys to complete after they had been admitted for greater than 24 hours and had received at least three main meals. The validated Foodservice Patient Satisfaction Survey[214, 215] was utilised to gather patient demographic data and measure foodservice satisfaction (covering meal quality and enjoyment, autonomy, staff consideration, and hunger and food quality) (Appendix B). The survey uses an 'always' to 'never' 5-point rating scale for the 38 questions relating

to foodservice satisfaction. However, as that survey only includes one question about the meal ordering service ('I am asked about my food and drink preferences'), a specifically designed Meal Selections Survey was developed to assess patient satisfaction with the meal ordering service and their interaction with the NA (such as were they visited by a NA and were they provided advice regarding the menu and meal choices) (Appendix C). The survey encompassed 5 questions, including yes/no (4 questions), multiple-choice (1 question) and opportunities for further comments.

Content validity was ensured by conducting a literature review on the topic and consulting with dietitians experienced in hospital foodservices to identify the major topics to include.[8] The survey was further tested for content validity and face validity by five dietitians, inviting them to review the draft questionnaire and using their professional judgement to determine whether the questions measure what is intended.[8] The survey was modified based on the initial feedback received, which included a small number of word modifications, and re-tested once more as the dietitians then reached a consensus. The survey was pilot tested during a pilot study at the Private hospital across two wards for a three day period, and no changes were required.[152]

The NA role was compared through a review of work schedules, observation, time recordings of patient contact, written surveys and semi-structured interviews. NA patient contact during menu delivery and pickup was observed and recorded by student dietitians to determine the time spent face-to-face with patients, and to document the communication themes. All NAs were provided with written pre- (paper menu) and post- (BMOS) implementation surveys to determine their preferred service model, and to assess if there were changes in the utilisation of their nutrition knowledge; patients' awareness of the NA role; and the level of menu selection assistance provided to patients. The survey encompassed 13 questions, including short answer (6 questions), multiple-choice (4 questions), yes/no (3 question) and opportunities for further comments for the private hospital (Appendix D). The NAs were also invited to participate in a short semi-structured interview with the primary researcher after the

BMOS was introduced in the private hospital study to discuss their overall thoughts about both services (Appendix E). Instead of the interviews, three additional questions were added for the public hospital study to also gauge NA perceptions on whether the service has increased the time spent with patients, improved work productivity or improved job satisfaction. The survey encompassed 16 questions, including short answer (6 questions), multiple-choice (7 questions), yes/no (3 question) and opportunities for further comments (Appendix F).

3.2.4 Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software (version 22, 2013, SPSS Inc., Chicago, IL, US). The Shapiro-Wilk test was performed to test for normality. Descriptive statistics (mean, count and percentages), Mann-Whitney U and Independent *t*-tests were performed to determine significant differences between the two cohorts and investigate the relationships between continuous variables, and Chi Square tests and z-tests were performed to analyse categorical data. The level of significance was set at $p<0.05$.

3.3 Results

3.3.1 Private hospital

Paper menu data were collected across five wards from 54 patients (75% response rate), and the BMOS data collected across the same five wards from 65 patients (95% response rate). The reasons patients declined included: medical reasons/acutely unwell (21) and without reason (7).

There were minimal number of significant differences between the paper menu and BMOS participant demographics. However, the average length of stay was one day shorter in the BMOS cohort, and the majority of the paper menu service cohort (59%) were admitted for orthopaedic surgery compared to 51% of the BMOS cohort admitted for general medical or gynaecological surgery (Table 3.1). Overall the study participants

(paper menu and BMOS combined) had an average age of 65.1 years, with an average length of stay 9.1 days, an average body mass index (BMI) of 28.5 kg/m^2 in the acceptable weight range adjusted for age ≥65 years (25-29.9 kg/m^2)[227], self-reported normal appetite and good health, and reflected a similar mix of "prescribed" diets and diagnoses. Unsurprisingly given the similarities in the participant demographics, there was no significant diference in the estimated energy or protein requirements between the two groups.

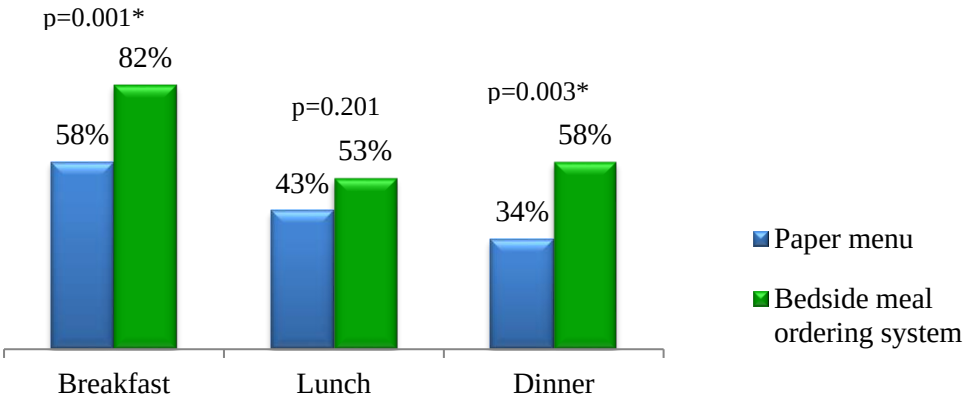
Table 3.1: Participant demographics (private hospital)

Data	Paper menu (n=54)	Bedside meal ordering system (n=65)	P value
Age [years, mean ± SD]	65 ± 14	66 ± 13	0.765
Gender [% female]	69%	59%	0.258
Length of stay (days, mean ± SD)	9.8 ± 9.7	8.5 ± 11.9	0.010*
Weight [grams, mean ± SD]	80 ± 19.5	79 ± 18.2	0.751
Body mass index [kg/m^{2,} mean ± SD]	29.6 ± 5.9	27.8 ± 5.5	0.364
Appetite [% normal or better]	75%	73%	0.582
Health, self-reported [% excellent, very good & good]	87%	78%	0.291
Diet types [n (%)]			0.101
Full	20 (37%)	29 (45%)	>0.05
Light	26 (48%)	20 (31%)	<0.05*
High protein/high energy	0 (0%)	2 (3%)	>0.05
Cardiac/diabetic	4 (7%)	2 (3%)	>0.05
Texture modified	3 (6%)	5 (8%)	>0.05
Allergy	1 (2%)	7 (11%)	>0.05
Medical classification [n (%)]			0.000*
Cardiac/Survey	6 (11%)	2 (3%)	<0.05*
Oncology/Surgery	6 (11%)	10 (15%)	>0.05
Orthopaedic/Surgery	9 (17%)	33 (51%)	<0.05*
General Medical/ Gynaecology/ Surgery	32 (59%)	12 (19%)	<0.05*
Orthopaedic Rehabilitation	1 (2%)	8 (12%)	<0.05*
Estimated dietary requirements			
Energy [kJ, mean ± SD]	7441 ±1265	7549 ± 1105	0.455
Protein [grams, mean ± SD]	80 ± 18	80 ± 15	0.660

* $\chi 2$ test and z-test used for nominal data, t-test used for parametric data and Man-Whitney U test used for non-parametric data to determine significance of differences ($p<0.05$ = significant)

Nutritional intake:

The observed food intake results demonstrated an increase in overall food consumption across all meals with the BMOS (p=0.029). On average 76% of the paper menu cohort consumed greater than 50% of their main meals, compared to 98% of the BMOS cohort (p=0.007). The number of patients who consumed 100% of their meal increased significantly with BMOS for breakfast and dinner (Figure 3.1). Food intake was significantly higher at breakfast compared to other meals (71% consumed all of breakfast, compared to 49% and 47% consuming all of lunch and dinner respectively) (p=0.001) in both paper menu and BMOS cohorts.



* $\chi 2$ test used to determine significance of differences ($p<0.05$ = significant)

Figure 3.1: Comparison of proportion of paper menu and BMOS participants who consumed 100% of the served meal.

The results of the dietary intake analysis from the tray photographs was consistent with the observation findings of an increase in intake between the paper menu and the BMOS across all meals, demonstrating the mean daily energy and protein intake increased significantly (both $p<0.05$) (Table 3.2). Energy intake increased significantly for all meals ($p<0.001$), as did protein intake, averaging between five and nine grams extra per meal (p=0.001) (Table 3.2). These intakes also reflected a significant increase in the percentage of energy and protein goals achieved (both $p<0.05$). Greater than half the BMOS participants met their estimated dietary goals (57% for energy and 50% for

protein), compared to approximately 30% of the paper menu participants (31% for energy and 28% for protein) (p=0.001 for energy and p=0.020 for protein).

Table 3.2: Participant dietary intake comparison (private hospital)

Data		**Paper menu** (n=54)	**Bedside meal ordering system** (n=65)	**P value**
Daily energy intake	[kJ, mean ± SD]	6273 ± 1818	8273 ± 2043	<0.001*
	(kJ, range)	(2769 – 10499)	(3465 – 13201)	
	Breakfast [kJ, mean ± SD]	1483 ± 735	2222 ± 1116	0.001*
	Lunch [kJ, mean ± SD]	1684 ± 565	2399 ± 858	<0.001*
	Dinner [kJ, mean ± SD]	1668 ± 762	2937 ± 903	<0.001*
Daily protein intake	[grams, mean ± SD]	66 ± 25	83 ± 24	0.001*
	(grams, range)	(22 – 135)	(29 – 134)	
	Breakfast [kJ, mean ± SD]	13 ± 7.8	18 ± 10	0.007*
	Lunch [kJ, mean ± SD]	22 ± 11	27 ± 10	0.028*
	Dinner [kJ, mean ± SD]	24 ± 16	33 ± 16	0.009*
Energy goal achieved	[mean, %]	86%	110%	0.001*
Energy goal achieved	[n (%)]			
	<50%	4 (8%)	1 (2%)	
	51-75%	12 (22%)	7 (11%)	
	76-99%	21 (39%)	20 (30%)	
	>100%	17 (31%)	37 (57%)	
Protein goal achieved	[mean, %]	86%	105%	0.020*
Protein goal achieved	[n (%)]			
	<50%	4 (8%)	3 (4%)	
	51-75%	20 (36%)	10 (15%)	
	76-99%	15 (28%)	20 (30%)	
	>100%	15 (28%)	32 (50%)	

* t-test used for parametric data and Man-Whitney U test used for non-parametric data to determine significance of differences (p<0.05 = significant)

The BMOS cohort selected a significantly greater number of menu item choices than the paper menu cohort for both lunch and dinner meals (p=0.001 for lunch and p=0.005 for dinner). Paper menu participants on average selected more items at breakfast (70% selected seven or more items compared to 40% for lunch and 39% for dinner), whereas the BMOS participants selected more items at dinner (78% selected seven or more items compared to 72% for breakfast and 60% for lunch). Only 8.5% of the paper menu

cohort had extra menu items recorded. This may indicate these patients did not realise they had the opportunity to request extra foods that were not on the menu. The BMOS cohort had the opportunity to order from the entirety of meal options for that day and were not limited to what was printed on the paper menu.

Patient satisfaction:

Overall foodservice satisfaction was very high from both cohorts, with 84% of the paper menu and 82% of the BMOS participants rating their overall satisfaction with the foodservice as 'very good' or 'good' ($p>0.05$). No participants from either cohort rated their overall satisfaction with foodservice as 'poor' or 'very poor'.

Only three of the thirty eight survey questions recorded a significant difference in responses between the paper menu and BMOS participants. Not surprisingly, the one question that related to the BMOS 'I am asked about my food and drink preferences' was reported more often in the BMOS group ($p=0.003$). The only other significant differences were 'chewing is difficult for me' ($p=0.044$), and 'the crockery and cutlery are chipped and/or stained' ($p=0.029$), both reported more often in the BMOS group who consumed more energy and protein.

Whilst overall foodservice satisfaction remained constant, most of the BMOS cohort preferred the BMOS system (80%), 14% preferred the paper menu service, and 6% did not mind either option ($p<0.001$). Verbal and written feedback from patients and anecdotal feedback from the wards from a variety of hospital staff indicated an enhanced NA presence on the wards with the BMOS systems. This outcome was not specifically measured as part of the study, but offers another positive benefit to the foodservice and nutrition departments, as well as the individual NAs.

NA role:

All of the NAs (n=6) completed the surveys pre- and post- implementation. Whilst there were no additional time (resources) required to complete the NA tasks during the

BMOS phase, the mean NA time spent with patients increased significantly from 0.33 to 3.5 minutes per patient per day ($p<0.001$).

Fifty percent of the NAs preferred the BMOS pre- implementation, and the same 50% reported preferring the BMOS after implementation. However, the interviews revealed that of the 50% who had expected to and reported preferring the paper menu, all agreed that there were many potential benefits to the patients and opportunities to utilise their nutrition knowledge and skills with the BMOS. They felt it was a lack of direction and a clearly defined work schedule that was the main cause of their preference to the paper menu system, as they were familiar with it and what was required of them throughout their shift. All of these staff felt that over time when they were comfortable and confident with the new process that the BMOS would be their preferred system.

3.3.2 Public hospital

Paper menu data were collected across three wards from 84 patients, and the BMOS data collected across the same three wards from 104 patients. Patient satisfaction was collected from 20 patients during the paper menu phase, and 38 patients during BMOS, due to the limited student time to distribute and collect the surveys. No patients declined to participate in this research.

There were significant differences between the paper menu and BMOS participant demographics for age, BMI and medical classification (all $p<0.05$). On average patients were eight years older and weighed approximately six kilograms less in the BMOS group. The majority of the paper menu service cohort were admitted in the general medical wards (45%) compared to 55% of the BMOS cohort who were admitted to the surgical wards (Table 3.3). However, there were no significant differences between the rest of the paper menu and BMOS study participant demographics. Overall, the study participants (paper menu and BMOS combined) were represented by 56% females, with an average length of stay 4.48 days, an average BMI of 28.8 kg/m^2 in the acceptable

weight range adjusted for age ≥65 years (25-29.9 kg/m^2)[227], and reflected a similar mix of 'prescribed' diets (all p>0.05). (Table 3.3). Despite some differences in the participant demographics, no significant difference in the estimated energy or protein requirements between the two groups was calculated (p=0.222 for energy and p=0.836 for protein).

Table 3.3: Participant demographics (public hospital)

Data	Paper menu (n=84)	Bedside meal ordering system (n=104)	P value
Age [years, mean ± SD]	63 ± 19	72 ± 15	0.002*
Gender [% female]	57%	56%	0.967
Length of stay (days)	4.35	4.61	<0.05*
Weight [grams, mean ± SD]	80 ± 24.7	74 ± 20.6	0.053*
Body mass index [kg/m^2, mean ± SD]	31.0 ± 9.0	26.6 ± 6.1	0.001*
Diet types [n (%)]			0.733
Full	49 (58%)	58 (56%)	
Light	3 (3%)	8 (7%)	
High protein/high energy	4 (5%)	2 (2%)	
Cardiac/diabetic	19 (23%)	24 (23%)	
Texture modified	9 (11%)	7 (7%)	
Allergy	0 (0%)	5 (5%)	
Medical classification [n (%)]			0.002*
General medical	38 (45%)	23 (22%)	
Surgical	36 (43%)	57 (55%)	
Oncology	10 (12%)	24 (23%)	
Estimated dietary requirements			
Energy [kJ, mean]	8954 ± 1728	8643 ±1728	0.222
Protein [grams, mean]	80 ± 18	81 ± 18	0.836

* $\chi 2$ test and z-test used for nominal data, t-test used for parametric data and Man-Whitney U test used for non-parametric data to determine significance of differences (p<0.05 = significant)

Nutritional intake:

The results of the dietary intake analysis from the tray photographs was consistent with the private hospital findings of an increase in intake between the paper menu and the BMOS across all meals, demonstrating the mean daily energy and protein intake increased significantly (both p<0.05) (Table 3.4). Energy intake increased significantly (p=0.035), as did protein intakes, averaging 25 grams extra for the BMOS cohort

(p<0.001) (Table 3.4). These intakes also reflected a significant increase in percentage of energy and protein goals achieved (both p<0.05). Significantly more BMOS participants met their estimated dietary goals (19% for energy and 46% for protein), compared to the paper menu participants (7% for energy and 19% for protein) (both p=0.021 for energy and p<0.001 for protein).

Table 3.4: Participant dietary intake comparison (public hospital)

Data		Paper menu (n=84)	Bedside meal ordering system (n=104)	P value
Daily energy intake	[kJ, mean ± SD]	5513 ± 2112	6232 ± 2523	0.035*
	(kJ, range)	(1501 - 12027)	(1438 - 12439)	
Daily protein intake	[grams, mean ± SD]	53 ± 24	78 ± 36	<0.001*
	(grams, range)	(8 - 106)	(6 - 165)	
Energy goal achieved [mean, %]		64%	73%	0.021*
Energy goal achieved [n (%)]				
	<50%	28 (33%)	24 (23%)	
	51-75%	31 (37%)	34 (33%)	
	76-99%	18 (21%)	26 (25%)	
	>100%	7 (8%)	20 (19%)	
Protein goal achieved [mean, %]		70%	98%	<0.001*
Protein goal achieved [n (%)]				
	<50%	28 (33%)	19 (18%)	
	51-75%	24 (29%)	16 (15%)	
	76-99%	16 (19%)	21 (20%)	
	>100%	16 (19%)	48 (46%)	

* t-test used for parametric data and Man-Whitney U test used for non-parametric data to determine significance of differences (p<0.05 = significant)

Patient satisfaction:

Overall foodservice satisfaction was very high from both cohorts, with 75% of the paper menu and 74% of the BMOS participants rating their overall satisfaction with the foodservice as ‘very good’ or ‘good’ (p>0.05). Only one of the survey questions recorded a significant difference between the paper menu and BMOS participants. This question was ‘I am disrupted by the noise of finished meal trays being removed’, which decreased with the BMOS cohort (p=0.004). Whilst overall foodservice satisfaction

remained constant, significantly more (84%) of the BMOS cohort preferred the BMOS, leaving only 16% who preferred the paper menu service ($p<0.001$).

NA role:

A total of 11 NA surveys pre-implementation and 14 post-implementation were completed. Whilst there were no additional time (resources) required to complete the NA tasks during the BMOS phase, the mean NA time spent with patients increased significantly from 1 to 5.43 minutes per patient per day ($p<0.001$).

Thirty six percent of NAs felt they would prefer the BMOS pre-implementation, and post-implementation the value increased significantly to 86% of NAs who reported preferring the BMOS ($p=0.047$). The utilisation of their nutrition knowledge and the assistance provided to patients remained consistent across the two cohorts (82% to 79% and 100% to 100% respectively). Overall NA reported awareness of their role increased, with staff awareness increasing from 73% to 79%, and patient awareness increasing from 73% to 86%. Despite the increased time spent with patients, only 64% of NAs felt they spent more time with patients with the BMOS. Fifty percent of NAs reported after the implementation of BMOS they felt an improvement in their work productivity, and 34% were unsure.

3.4 Discussion

Numerous dietetic strategies have been implemented to address the issue of hospital malnutrition, but none have considered a BMOS as an opportunity. These two studies reflect the first comprehensive evaluation of the impact of a hospital BMOS, demonstrating significant improvements in dietary intake which is associated with improved patient outcomes and LOS.[228-230] Patients increased both the quantity of menu items they selected, as well as the percentage of overall meal being consumed using the BMOS. In addition, patient satisfaction, staff satisfaction and NA presence on the wards were also enhanced.

Patterns of observed dietary intake in the private hospital study were consistent with findings of other Australian hospital studies, with a significantly greater quantity of the meal being consumed at breakfast compared to the other main meals.[27, 231] However, the nutrition analysis identified that patient energy and protein intake continued to increase significantly over the day, with dinner being the highest contributor to dietary intake. The number of menu items selected at each main meal also did not correlate with the dietary intake, suggesting that the menu items offered at lunch and dinner may be more nutrient dense than those at breakfast. Perhaps, given these findings, a greater variety of energy and protein dense breakfast items could be encouraged to take advantage of the time patients are consuming a greater proportion of their meal.

Poor appetite is the most frequently reported reason for poor dietary intake,[27, 100] with some of the contributors to appetite beyond patient illness relating to the patient's mood, depression status and feelings of social isolation.[101] In addition, patient eating patterns and meal preferences can change over the period of their hospitalisation, such as a preference for smaller more frequent meals.[102] These studies have demonstrated that patient engagement through HIT has created an opportunity to increase dietary intake, and may be a valuable strategy to enhance feelings of engagement and consequently the appetite of patients. The NA can offer an important link between the patient and their meal, and assist patients to make suitable menu choices to meet their requirements and food and meal pattern preferences.

In addition, the BMOS enabled a significant increase in NA time for direct patient interaction and participation, assistance with preferred and suitable menu choices and offered an increased menu choice, without an increase in staff resource requirements to complete their role. This additional time was created from the automation of the diet office tasks, and the elimination of the manual tasks, such as collating and correcting menus, tallying of menu items and creation of labels. Consequently, the patients reported preferring the personalised service the BMOS enabled due to feeling informed and involved in their decisions, having questions and concerns resolved immediately,

being more efficient, and environmentally friendly. The results of this study suggest that patient participation and feelings of involvement may have a significant impact on patient dietary intake in addition to foodservice satisfaction. Other studies have indicated the benefits of increased menu choice for improving dietary intake,[193] increasing patient involvement through interaction with a NA for improving satisfaction,[167, 169] and patient wellbeing/emotions as an important predictor of dietary intake.[165]

The improvement in staff satisfaction was predominantly a result of a change in work practice from office-based administration duties to utilising their nutrition knowledge and skills to directly care for and assist patients. Staff acceptance and increased satisfaction with a substantial change in their daily operations and departmental role is crucial for the long-term success of the service, as well as for widespread potential for adoption by other healthcare facilities. An unexpected benefit for the private hospital staff and the foodservice and nutrition departments was an enhanced staff presence on the wards, providing an opportunity for education, and an enhanced feeling of value by the NAs. While 50% of the private hospital staff survey responses suggested they still preferred the paper menu, the interviews revealed it was not a reflection of the new system, just a temporary discontent with the lack of guidance and work schedule development to support their new processes.

The principal limitation of these experimental studies was the pre-test post-test cohort design. However, a RCT was not a feasible option within a live hospital environment with the rollout of a new electronic system affecting the entire hospital. However, repeating this study in two hospitals with the same research design, data collection processes and analysis, producing comparable results, helps to strengthen the confidence in the outcomes being attributed to the BMOS. One facility was a private hospital in New South Wales, and the other was a public hospital in Queensland. Both had different menus and a different menu cycle length. The two cohorts of participants in the private hospital study were closely matched by gender, anthropometry, medical

classification and dietary requirements, so it is unlikely that these factors would have had a significant impact on the results. The demographics of the public hospital study however did show some significant differences, and therefore the groups were less comparable, which is a limitation of that study. Another confounding factor in the public hospital study was a minor menu review between the pre- and post- data collection, which may have contributed to improved outcomes.

There were several student dietitians involved in the data collection, and consequently there may be inconsistencies between individuals for the recording of the observational dietary intake data, which could impact on the results. However, the results of the observational data reflected the analysis of the photographed dietary intake, suggesting there were minimal discrepancies. While the month of the year in which the private hospital study was undertaken was close (September/November), there was some difference in the mean monthly temperatures in those months (21.7° and 24.7°C respectively) but any major influence on food selection in the air conditioned environment of the hospital is unlikely. The research in the public hospital study occurred in the same month with no mean difference in temperatures.

Whilst the an average BMI of 28.7 kg/m^2 across the two study groups is in the acceptable weight range adjusted for age ≥65 years (25-29.9 kg/m^2),[227] the study didn't assess the risk or prevalence of malnutrition amongst the participants. Measuring the nutritional status of the study patients using a validated tool such as the SGA would have provided additional useful information demographic data for these study populations.[232] With the average prevalence of malnutrition reported in the Australian (and international) acute healthcare setting 20-50%,[93] the potential of a BMOS for improving hospital patient dietary intake and providing targeted advice and education is still a significant finding. Future research is required to identify if the BMOS has the same potential to improve patient dietary intake across all hospital patient populations, with a particular focus on patients at highest risk.

These studies demonstrate there is potential for hospitals and dietitians to re-orientate services and embrace patient participation through nutrition informatics to:

- Enhance patient dietary intake, especially in the nutritional ‘at risk populations.
- Maximise efficiency of NA time through the automation of manual tasks.
- Increase patient interaction and engagement in relation to meal ordering and nutritional intake.
- Increase effectiveness of dietetics care (through the improvement in nutritional intake).

To maximise the opportunities to embrace nutrition informatics and achieve the potential benefits, a framework to determine eHealth readiness to support improving dietitian engagement is required (Chapter 4).

CHAPTER 4: DEVELOPMENT OF AN EHEALTH READINESS FRAMEWORK

* The majority of Chapter 4 has been submitted for peer review:
Maunder K, Williams P, Walton K, Ferguson M, Beck E. (2017) An eHealth readiness framework for dietitians. *International Journal of Medical Informatics,*' revisions submitted'.

*The Framework dimensions and diagram have been peer reviewed and presented at a conference and the abstract included in the following publication:
Maunder K, Walton K, Williams P, Ferguson M, Beck E. (2017). eHealth readiness of Australian dietitians. 34th National Conference of the Dietitians Association of Australia, Hobart. *Nutrition and Dietetics,* Vol 74 (Suppl. S1):10-11.

4.1 Introduction

Having demonstrated the potential benefits to dietitians to be gained with the introduction of an eHealth solution (Chapter 3), realising the benefits is the challenge in the complex environment of healthcare. Successful HIT implementations require careful planning and management of the organisational change that comes with technology disruption.[84] HIT solutions are not without risk, and without the right solution and clinical readiness and engagement, the costs of failure (both financially and patient-related) can be significant.[233, 234]

Whilst the integration of eHealth has initially focused on medical practitioners and nurses, it will inevitably impact on the practice of the allied health professionals, including dietitians. Tools for assessing HIT readiness have been demonstrated to reduce project implementation risk,[82-84] however, there is not a common or accepted framework known to healthcare, allied health or dietitians specifically. Consequently, a dietitian eHealth readiness framework for the analysis and identification of areas for professional improvement or to guide eHealth system implementations is an important first step in preparing and supporting eHealth readiness, and ultimately enabling the benefits of eHealth to be realised by the profession.

With the demonstrated benefits of nutrition informatics and the knowledge that professional eHealth readiness is a key factor in HIT implementation success, this study will identify the key dimensions essential for dietitian eHealth readiness.

4.1.1 Aim

The aim of this study was:

To develop and validate a framework to assess dietitian eHealth readiness. (Objective 2)

The objectives were to identify:

1. If there are any frameworks for the assessment of dietitian or allied health professional eHealth readiness.
2. If there is any literature that could guide the development of a dietitian (allied health professional) eHealth readiness assessment framework.

4.2 Methods

Using an inductive approach this research was divided into two stages, reported below: SLR, data synthesis to identify eHealth readiness themes and develop a draft framework; and semi-structured interviews with Australian nutrition informatics experts to gain consensus and validate the framework.

4.2.1 Systematic literature review

The SLR aimed to identify literature on eHealth readiness themes relevant to dietitians. The search protocol was conducted according to the PRISMA statement[171] and reported using a narrative synthesis. Searches were conducted in Scopus, CINAHL, Medline, Cochrane and Web of Science databases for peer-reviewed scholarly articles published from the earliest date until December 2016 (when the search was being performed). These databases were selected due to their relevance for journals in the field of health informatics. Search terms were determined through searching the literature, a Medical

Subject Headings (MeSH) on Demand search and a Google search, and pilot tested to check that appropriate papers were being identified. The final search terms were related to 1. healthcare and Information Technology ('eHealth', 'health informatics', 'medical informatics', 'Health Information Technology', 'health information systems', and 'hospital information systems') and 2. readiness ('readiness' or 'preparedness'). The full details of the electronic search strategies can be found in Appendix L. Additional articles were identified for inclusion through reference harvesting of included papers and a key author search based on these reference lists. A Google search was also conducted to identify additional non-journal publications (grey literature) on eHealth readiness frameworks.

The identified article titles and abstracts were studied to remove duplications and exclude any articles which did not meet the inclusion criteria: English language articles; full-text; and including a model, framework or identified themes of eHealth readiness. The remaining articles were assessed to identify unique empirical research specifically identifying a model, framework or themes for assessing eHealth readiness. Due to the paucity of articles with a focus on health professionals, those with a broader country/region or organisational focus were included for synthesis, as were those focusing on a specific eHealth field (such as telehealth), even if they did not specify or label a model, framework or themes. The broad topics still provided relevant insight into the potential readiness dimensions that could apply to health professionals for eHealth. Articles focused solely on patients or consumers were excluded.

All included articles were reviewed and key data extracted to a summary table for further analysis. The summary table included the authors, year and country of the study, model or framework name and description, study design, readiness dimensions or themes, and setting or target group and application.

4.2.2 Data synthesis and framework development

Following the data analysis phase of the literature review, the articles were reviewed for eHealth readiness themes applicable to dietitians. Key sentences and descriptions of the themes were also recorded. The themes were categorised into related groups to form the framework dimensions, and the descriptions reviewed and summarised to form the framework dimension descriptions. The themes, groupings and dimensions were reviewed and refined to achieve the draft framework table.

The identified eHealth readiness dimensions were extracted and overlapped around a central goal of eHealth readiness of dietitians, and a draft framework diagram created. The dimension descriptions were abbreviated and included in the diagram.

4.2.3 Interviews and framework validation

Semi-structured interviews with nutrition informatics experts were employed to identify perceived attributes of eHealth readiness of dietitians and to develop consensus and validate the framework. Interview participants were invited to participate through a combination of purposive and snowball sampling. The selection of dietitian nutrition informatics expert participants was based on four main criteria: their experience with a nutrition-related eHealth implementation; research and publication on eHealth solutions for dietitians; role at a national level as an advocate for eHealth for dietitians; or CHIA credentials. Ethics approval was granted HE16/202 by the University of Wollongong Human Research Ethics Committee.

The interviews consisted of four key questions. Firstly, participants were asked ‘what attributes would you consider reflects a profession’s readiness for eHealth?’ (Question 1). They were then shown the draft framework diagram and asked Question 2: Do you feel this framework covers all of the dimensions of dietitian eHealth readiness?; Question 3: Do you feel the dimension names and definitions are suitable?; and Question 4: Do you have any other suggestions? (Appendix G).

The digitally recorded interviews were conducted by the primary researcher, face-to-face or over the phone with participants. The interviews were transcribed verbatim by the same researcher. A thematic analysis approach [235] was applied to Question 1 (attributes of eHealth readiness) whereby the text was labelled as an open code and then once the transcript was coded, then all codes were grouped into categories to form the key themes within Microsoft Excel 2010. Key sentences and descriptions of the themes were also recorded. The researcher then compared the identified themes to those identified in the literature to determine overlap and differences, and update the framework table and diagram based on the literature and interviews. Responses to Question 2 formed part of the validation process, with responses being recorded as the percentage of consensus against each dimension. Responses to Questions 3-4 were recorded, and incorporated into the review and refinement of the dimension names and definitions, to achieve the final framework. Due to the nature of questions 2-4, the responses were coded descriptively within Microsoft Excel 2010.

4.3 Results

4.3.1 Systematic literature review

Four hundred and eleven articles were identified, and after the removal of duplicates, 241 articles were reviewed. Two hundred and twenty one articles were excluded based on title or abstract, as they were not related to a framework, assessment model or identifying themes of eHealth readiness. The setting (whether it was a specific country/countries or region/s or organisation type, such as primary care, rural or remote settings or public or private practice) and the application (whether it was eHealth in general or specific applications, such as telehealth or telemedicine), were not limited within the search. Many of the research studies identified in the search related to a specific eHealth intervention or consumer or community interest in eHealth, and consequently were excluded. An additional 16 articles were found via hand searching reference lists and a Google search. Thirty six full text articles were assessed; twelve articles were excluded, leaving 24 articles for the data synthesis (Figure 4.1). The articles were excluded for the following reasons: articles that utilised an already

published eHealth readiness framework (n=4), or did not report on a framework or assessment model (n=8. There were 15 unique authors that contributed to the final 24 articles. Twenty one articles were peer-reviewed, and three identified during the Google search, which were included due to their relevance to the topic. Of these three articles, the Australian government published two [158, 236] and Cisco and the Region of Southern Denmark jointly published the third (Pederson et al, 2013).[237]

4.3.2 Study characteristics

Results of the literature review analysis (Table 1) revealed the studies were conducted across a variety of countries, including United States of America (USA) (6), Australia (5), Canada (5), Pakistan (2), Europe (1), Iran (1), Italy (1), Lebanon (1) South Africa (1) and United Kingdom (1). The setting or target of each study differed, with most being healthcare organisations (15), followed by health practitioners (primarily physicians and nurses) (4), rural communities (3), primary care (1) and country/region (1). The health-based application also differed in each study, with the majority focused on eHealth (15), followed by telehealth (6), EHR (2) and health information exchange (1).

Of the four articles that included data on health practitioners, only one study specifically targeted allied health professionals and eHealth readiness, published in an Australian government report in 2011.[158] Two studies were conducted in the rural healthcare setting and targeted a variety of levels, including medical practitioners, patients, administration staff and the organisation, with a specific focus on telehealth.[238, 239]

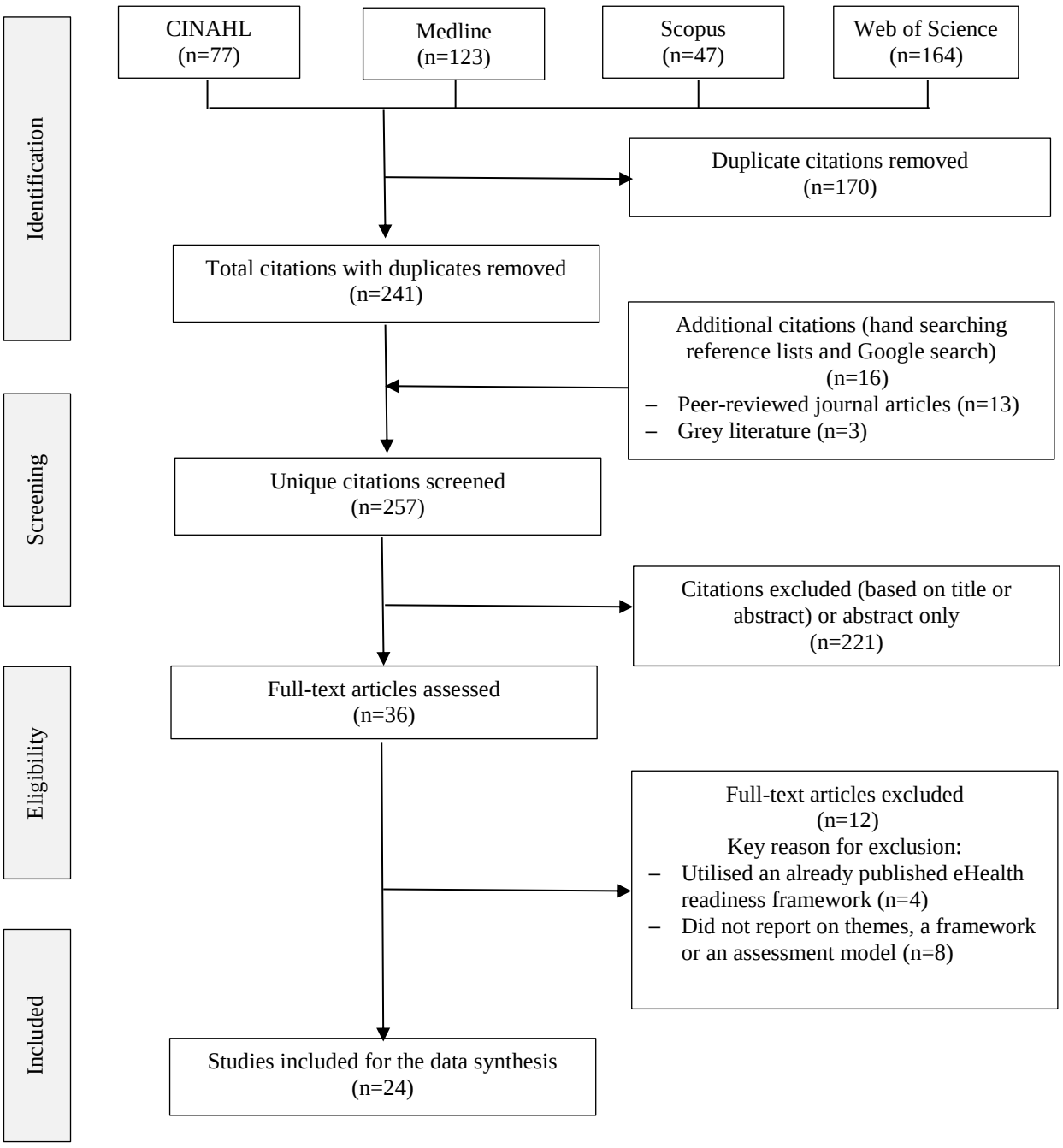


Figure 4.1: PRISMA flow chart for selection of studies on eHealth readiness.

4.3.3 Data analysis

Of the 24 studies included for synthesis, ten utilised a readiness framework to analyse the data, and 13 developed a framework or identified themes for the analysis of readiness. One Australian government report on allied health eHealth readiness identified the importance of clinical engagement in eHealth, and investigated three dimensions of readiness: infrastructure, attitude and aptitude.[158] Whilst the theories and models identified in this literature review focus on a variety of different settings or targets and applications, the commonality is that they seek to determine the factors that contribute to eHealth readiness and how this assessment process can be modelled and predicted using theoretical and empirical approaches. Given the varied nature of articles, it was not possible to utilise a single tool in relation to study quality,[240] and all of the models were analysed to identify factors that may contribute to eHealth readiness of dietitians.

Table 4.1: Summary of studies included in the synthesis

Author (Country)	Publication/s (Year)	Setting / Application	Framework	Readiness dimensions / themes	Study type / assessment tool
Snyder-Halpern R[241-243] (US)	Assessing health care setting readiness for point of care computerised clinical decision support system innovations. **(1999)** Indicators of organizational readiness for clinical information technology/systems innovation: a Delphi study. **(2001)** Measuring hospital readiness for information technology (IT) innovation: a multisite study of the organisational information technology innovation readiness scale. **(2006)**	Organisation / eHealth	Described and applied a Clinical information technology innovation model (CITIM) – earlier version of the OITIM framework. Developed a framework of indicators for organisational readiness for clinical information technology/system innovation, called the: organisational information technology/systems innovation model (OITIM) framework (Figure 4.2). Developing an assessment tool (organisational information technology/systems innovation readiness scale (OITIRS)) based on this framework. Validation of the OITIM sub-dimensions, and designing and pilot testing the OITIRS.	Sub-dimensions (7): 1. Knowledge 2. Staffing and skills 3. Technology 4. Operations 5. Processes 6. Resources 7. Values and goals	Description of the CITIM and a case illustration showing the CTIM application. An expert panel using a two-round modified Delphi technique to develop framework and tool/ questionnaire. Multi-site study to re-evaluate the psychometric adequacy of the OITIRS in a larger sample.

Author (Country)	Publication/s (Year)	Setting / Application	Framework	Readiness dimensions / themes	Study type / assessment tool
Campbell et al [238] (US)	Introducing telemedicine technology to rural physicians and settings. **(2001)**	Rural healthcare providers (physicians, nurses and administrative personnel) / telehealth	Developed a framework for assessing rural health providers' readiness to adopt telemedicine. Provided strategies for implementing new technology documented based on level of readiness.	Themes (6): 1. Turf 2. Efficacy 3. Practice context 4. Apprehension 5. Time to learn 6. Ownership	Semi-structured interviews and thematic analysis.
Jennett et al[82, 83, 233, 239] (Canada)	A study of a rural community's readiness for telehealth. **(2003)** The essence of telehealth readiness in rural communities: an organizational perspective. **(2005)**	Rural communities (patient, practitioner, public and organisation) / telehealth	Identified themes that can be used to investigate the readiness of rural and remote communities for telehealth.	Types (4): 1. Core 2. Engagement 3. Structural 4. Non-readiness Main themes within types of readiness (6): 1. Core readiness 2. Structural readiness 3. Projection of benefits 4. Assessment of risk 5. Awareness and education 6. Intra-group and inter-group dynamics	Semi-structured interviews, community awareness sessions and focus groups.

Author (Country)	Publication/s (Year)	Setting / Application	Framework	Readiness dimensions / themes	Study type / assessment tool
Continued: Jennett et al[82, 83, 233, 239] (Canada)	Organisational readiness for telemedicine: implications for success and failure. **(2004)**	Organisation / telemedicine	Identified themes of organisational readiness and examples of success and failure in telemedicine implementation.	Themes (11): Planning readiness 1. Telemedicine strategic plan 2. Needs assessment and analysis 3. A business plan 4. Leadership readiness Workplace readiness (human resources and structural readiness) 5. Preparing staff 6. Telemedicine coordinator 7. Change management readiness 8. Technical readiness 9. Policy 10. Access 11. Communication and participation Factors contributing to failure: 1. Inadequate needs assessment and lack of buy-in 2. Lack of staff preparation 3. Resistance to change	Semi-structured interviews and analysed using an iterative qualitative approach.
	Preparing for success: Readiness models for rural telehealth. **(2005)**	Rural and remote health / telehealth	Analysed of published telehealth readiness models within rural communities.	Common themes (3): 1. An appreciation of practice context 2. Strong leadership 3. Perceived need to improve practice	Literature review and analysis of readiness models.

Author (Country)	Publication/s (Year)	Setting / Application	Framework	Readiness dimensions / themes	Study type / assessment tool
Overhage et al[244] (US)	Communities' readiness for Health Information Exchange: the national landscape in 2004. **(2005)**	Government agencies, national associations and organisations / Health Information Exchange	Developed a questionnaire based on 7 dimensions; and data analysed based on 4 topics to assess communities' readiness for Health Information Exchange.	Question categories (7): 1. Clinical component 2. Leadership 3. Funding 4. Technical readiness 5. Business plans 6. Data standards 7. Replicable and scalable tools Data analysis topics (4): Organisational phase; technical approaches; data and standards; and initial funding and sustainability.	Questionnaire and analysis.
Wickramasinghe et al[245] (US)	A framework for assessing eHealth preparedness. **(2005)**	Country/ region / eHealth	Developed a framework and e-health preparedness grid for assessing a country's/region's eHealth potential (Figure 4.3).	Main pre-requisites (4): 1. Information communication technology architecture/infrastructure 2. Standardisation policies, protocols and procedures 3. Government regulations and roles 4. User access and accessibility polices and infrastructure	Presentation of assessment framework and eHealth preparedness grid.

Author (Country)	Publication/s (Year)	Setting / Application	Framework	Readiness dimensions / themes	Study type / assessment tool
Mannan et al[246] (UK)	Is primary care ready to embrace e-health? A qualitative study of staff in a London primary care trust. **(2006)**	Primary care / eHealth	Identified the perceptions of primary care staff regarding the readiness to implement eHealth initiatives.	Recurrent themes (6): 1. Perceptions of technology 2. Issues relating to resources 3. Patient choice 4. Confidentiality and security 5. Political pressure	Interviews of staff from primary practices.
Khoja et al[6, 247] (Pakistan)	e-Health readiness assessment tools for healthcare institutions in developing countries. **(2007)** E-health readiness assessment: Promoting hope in the health-care institutions of Pakistan. **(2008)**	Public and private healthcare institutions in developing countries / eHealth	Identified themes/assessment categories and developed eHealth readiness assessment tools for managers and healthcare providers.	Readiness categories (4): 1. Core readiness 2. Societal readiness 3. Policy readiness 4. Technological readiness *(for managers)* and 4. Learning readiness (*for healthcare providers)*	Expert opinion, literature review and in-depth semi-structured interviews.
Ajami et al[248] (Iran)	Readiness assessment of electronic health records implementation. **(2011)**	Organisation / EHR	Utilised a Community Clinic EHR Readiness Assessment tool.	Assessment sections (4): 1. Organisational alignment 2. Management capacity 3. Operational capacity 4. Technical capacity	Review article of literature on EHR readiness assessment.

Author (Country)	Publication/s (Year)	Setting / Application	Framework	Readiness dimensions / themes	Study type / assessment tool
Australian Government[158, 236] (Australia)	The eHealth readiness of Australia's allied health sector. **(2011)** The eHealth readiness of Australia's medical specialists. **(2011)**	Health practitioners (allied health and medical practitioners) / eHealth	Dimensions identified to analyse survey and interview questions.	Dimensions (3): 1. Infrastructural readiness 2. Aptitudinal readiness 3. Attitudinal readiness	Interviews and surveys.
Pare et al[249] (Canada)	Clinicians' perceptions of organisational readiness for change in the context of clinical information system projects: insights from two cross-sectional surveys. **(2011)**	Organisation / clinical information system projects (eHealth)	Classes of variables were identified and tested to develop a research model to identify variables associated with clinicians' perceptions of organisational readiness. The variables were based on Holt et al's 'Readiness for organisational change' [250] to relate directly to healthcare.	Classes of variables (4): 1. Attributes of the change 2. Leadership support 3. Internal context 4. Attributes of the change targets	Two cross sectional surveys to test the research model.
Li et al[84, 251] (Australia)	An eHealth readiness assessment framework for public health services - pandemic perspective. **(2012)** Issues Regarding the Implementation of eHealth: Preparing for Future Influenza Pandemics. **(2012)**	Public health services / eHealth – for a pandemic response	Developed a framework of eHealth readiness assessment for a pandemic from a healthcare organisational and providers' perspectives (Figure 4.4).	Dimensions (5): 1. Motivational readiness 2. Engagement readiness 3. Technological readiness 4. Resource readiness 5. Societal readiness	Literature review and interviews.

Author (Country)	Publication/s (Year)	Setting / Application	Framework	Readiness dimensions / themes	Study type / assessment tool
Continued: Li et al[252] (Australia)	E-Health Readiness Framework from Electronic Health Records Perspective. **(2010)**	Healthcare organisations / EHR	Developed an eHealth readiness assessment framework (EHRAF) for healthcare organisations for EHR.	Components (4): 1. Core 2. Engagement 3. Technological Societal	Literature review and framework development.
Tamburis et al [253] (Italy)	The LITIS conceptual framework: measuring eHealth readiness and adoption dynamics across the Healthcare Organizations. **(2012)**	Healthcare organisations / eHealth	Developed the LITIS conceptual framework for measuring eHealth readiness of healthcare organisations (Figure 4.5).	Functions (3): 1. Citizens 2. Healthcare professionals 3. Managers and administrators Components (3): 1. Technological infrastructures 2. Applications 3. Non-technological	Literature review and questionnaire.
Coleman et al [254] (South Africa)	Activity Theory Framework: A basis for eHealth readiness assessment in health institutions. **(2013)**	Health institutions / eHealth	Developed a framework that maps the identified eHealth readiness constructs onto the activity theory analytical components (Figure 4.6).	Categories/constructs (4): 1. Need-change readiness 2. Engagement readiness 3. Technological readiness 4. Societal readiness	Literature review and semi-structured interviews.

Author (Country)	Publication/s (Year)	Setting / Application	Framework	Readiness dimensions / themes	Study type / assessment tool
Pederson et al[237] (Europe)	Readiness evaluation model: TREAT: Telemedicine readiness assessment tool. **(2013)**	Regions and healthcare organisations (leaders and funding partners) / telemedicine	Developed the TREAT: Telemedicine Readiness Assessment Tool framework which guides telemedicine assessment – encompassing a readiness assessment tool and facilitated workshops (Figure 4.7).	Organisation enablers (3): 1. Leadership and Collaboration 2. Measurement and Evidence 3. Governance and Sustainability Technological and operational enablers (3): 1. Capacity and Competence 2. Standards and Interoperability 3. Infrastructure and Architecture	Presentation of a telemedicine readiness assessment tool.
Saleh et al [255] (Lebanon)	Readiness of healthcare providers for eHealth: the case from primary healthcare centers in Lebanon. **(2016)**	Healthcare providers / eHealth	Determination of sections and factors to develop a questionnaire. The third section was adapted from Holt et al's 'Readiness for organisational change' [250] to relate directly to healthcare.	Sections (3): 1. Socio-demographics 2. Computer use, computer literacy and computer access 3. Readiness for organisational change (4): a. Appropriateness of eHealth applications b. Management support c. Change efficiency d. Personally beneficial	A self-administered questionnaire.

The diagrams depicting the models and frameworks that were summarised and referenced in Table 4.1 are pictured below:

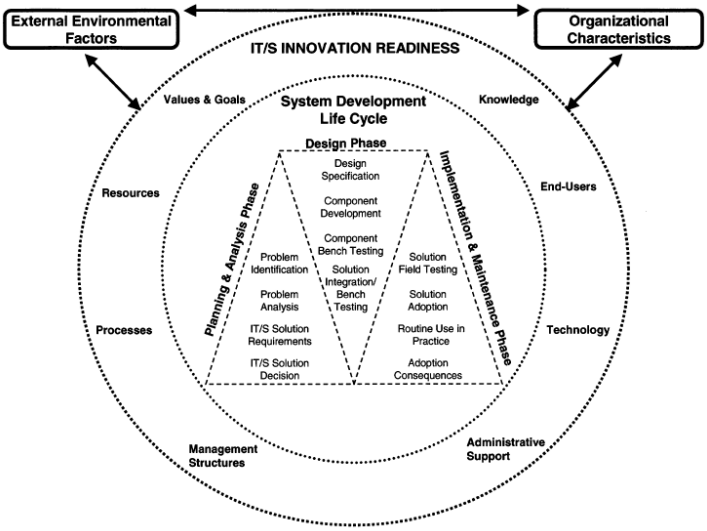


Figure 4.2: Snyder-Halpern's Heuristic Organisational Information Technology/Systems Innovation Model (OITIM).[242]

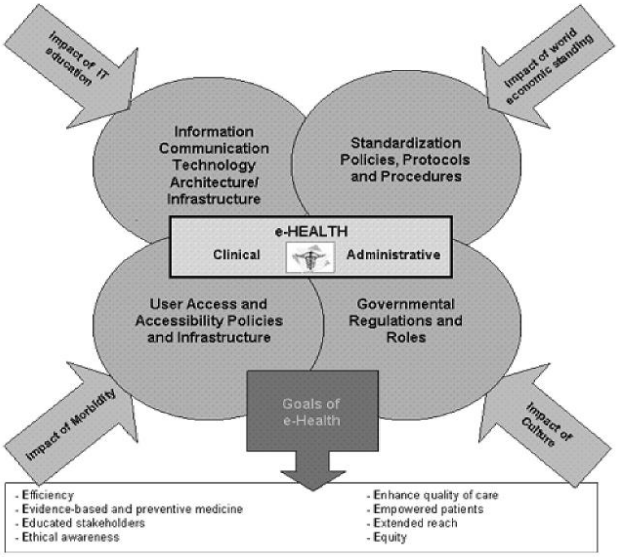


Figure 4.3: Wickramasinghe et al's Framework for assessing a country's/region's eHealth potential.[245]

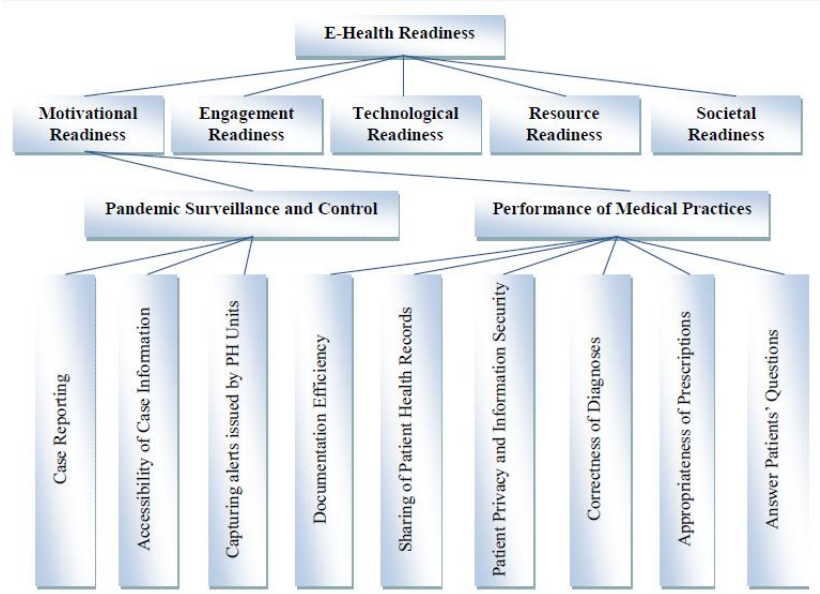


Figure 4.4: Li's dimensions of E-Health readiness for a pandemic.[84]

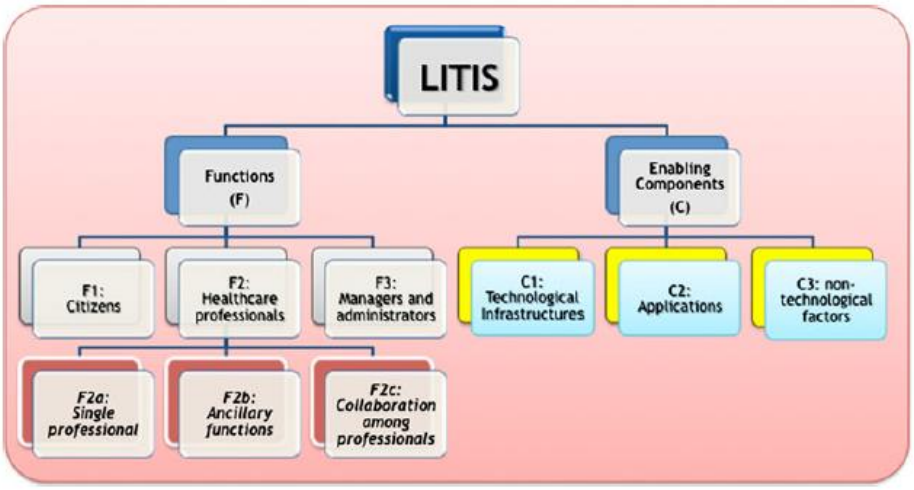


Figure 4.5: Tamburis's top-level model of the LITIS Conceptual Framework.[253]

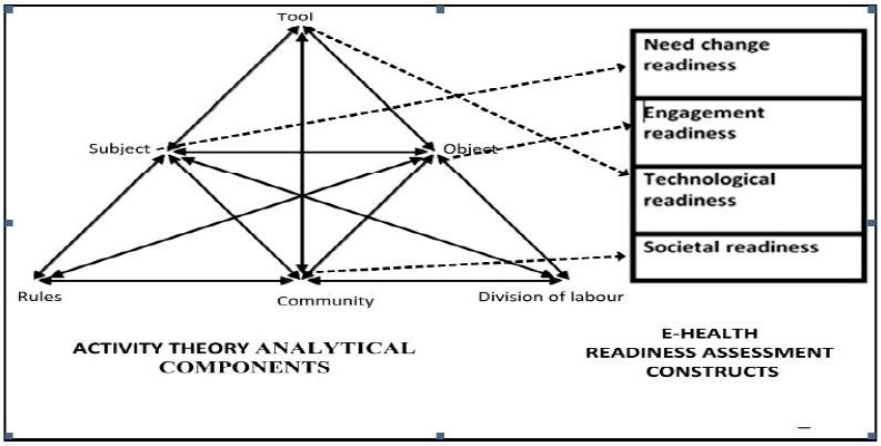


Figure 4.6: Coleman's mapping of activity theory.[254]

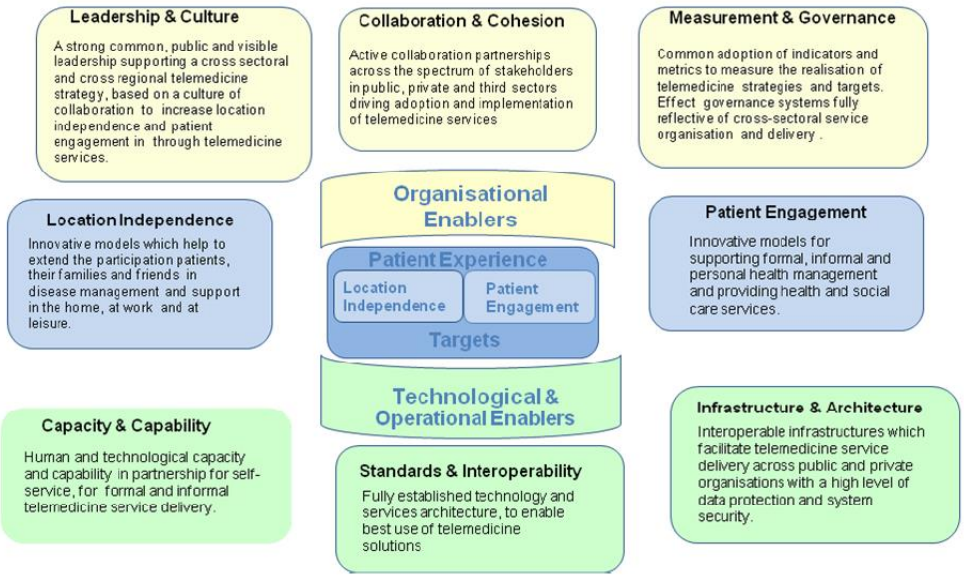


Figure 4.7: Pederson's TREAT (Telemedicine Readiness Evaluation Assessment Tool) Workshop.[237]

4.3.4 Data synthesis and framework development

Common eHealth readiness themes or dimensions were identified across the articles, and all that were relevant to dietitians were tabled with a brief description, and the supporting literature referenced (Table 4.2). The key relevant dimensions extracted for the literature included access, standards, attitude, aptitude and advocacy. Due to

the setting, target group and application in focus, none of the identified articles referenced all of these five dimensions. The majority of authors (7) referenced two of these dimensions, with four authors referencing three dimensions, and two more referencing four of the five dimensions.

Of the fifteen contributing authors, thirteen identified *access* in some form, reporting on IT infrastructure, architecture, structural and/or resource readiness.[6, 44, 84, 158, 237, 239, 241-244, 246, 248, 252-255] One author only identified funding as a core readiness requirement, [256] whilst another highlighted funding, but within the theme of structural readiness.[233] HIT infrastructure and funding is fundamental to any eHealth project, and could be considered the first step in preparing for any HIT project. The dimension is more clearly described as: access to the required IT infrastructure (including hardware, software/apps and networks) and funding.

Authority/Standards were referenced by eight of the contributing authors and referred to in a variety of terms, such as data and standards, processes, policies, protocols, procedures, regulations and interoperability.[6, 44, 83, 237, 241-243, 248, 253, 256] Consequently the description was developed to encompass all of these components: documented terminology and process standards to support practice and processes of the practitioner.

Ten of the authors referenced *Attitude*, and it was the dimension with the greatest variety of descriptions, all listed in Table 4.2.[6, 84, 158, 238, 239, 241-243, 246, 249, 252, 254, 255] This dimension is complex as it encompasses several individual traits in relation to HIT, and therefore was described as: awareness of the need to change; knowledge of the benefits of eHealth; and willingness to utilise eHealth solutions.

Aptitude is more easily defined as the: ability to utilise eHealth solutions. This dimension was referenced by six of the authors, including terms such as aptitude,

knowledge, education, capacity and competence.[158, 237, 239, 241-243, 249, 255] This was described as the: ability to utilise eHealth solutions.

Ownership, leadership and collaboration were topics listed by eight of the authors, incorporated into the dimension of *Advocacy*.[82, 83, 158, 237, 238, 248, 249, 255, 256] Whilst often not referenced, the discussion of advocacy is compelling, and is probably the key dimension in eHealth readiness that is often overlooked. A SLR conducted by Ingebrigtsen et al.[43] provided evidence that clinical leaders can have a positive impact on the success of HIT adoption in healthcare organisations, supporting the importance of including this as a dimension. Consequently this dimension was listed last in the table, representing an advanced stage of preparing for a successful eHealth system implementation: capacity for leadership and ownership of eHealth initiatives.

Based on the initial themes and descriptions developed from the literature review, a draft framework diagram was created and abbreviated to FeRD (Framework for eHealth Readiness of Dietitians) (Appendix G).

Table 4.2: Development of the dietitian eHealth readiness framework

Proposed readiness dimension	Detailed description	Supporting readiness dimensions from the literature that apply to a health practitioner
Access	Access to the required information technology infrastructure (including hardware, software/apps and networks) and funding.	Technological[6, 83, 84, 241-244, 247, 248, 251, 252, 254], technological infrastructural[248, 253] Access to computers at work[252, 255] Appropriateness (of applications within their context)[255] ICT architecture/infrastructure[44, 237], infrastructural[158, 236] Resources[84, 241-243, 246, 248, 251, 252] Structural readiness[82, 233, 239] Funding[233, 256]
Authority/ Standards	Documented terminology and process standards to support the practice and processes of the practitioner.	Processes[241-243] Data and standards[256] Standardisation policies, protocols and procedures[44, 248], policy[6, 83, 247] Policies and regulations[253] Standards and interoperability[237]
Attitude	Awareness of the need to change; knowledge of the benefits of eHealth; and willingness to utilise eHealth solutions.	Turf (perception of eHealth as a threat to competency or autonomy); efficacy; practice context; apprehension; and time to learn[238] Core[6, 82, 83, 233, 239, 247, 248, 252], motivational[84, 251], need-change readiness[254] (the realisation of needs and expressed dissatisfaction with the present situation and conditions), vision clarity (the sense that change is needed)[249], personally beneficial[255] Engagement[84, 233, 239, 248, 251, 252, 254] Attitudinal[158, 236] Awareness and education[83, 233, 239] Perceived need to improve practice[82] Efficacy[238], projection of benefits[239], aware of benefits[246], change appropriateness[249], assessment of risk[239] Self-efficacy[249] Practice context[82, 238] Apprehension[238] Time to learn[238] Values and goals[241-243]
Aptitude	Ability to utilise eHealth solutions.	Knowledge[241-243] Computer literacy[255] Change efficacy[249, 255] Staffing and skills[241-243] Aptitudinal[158, 236] Awareness and education[233, 239], preparing staff [83] Capacity and competence[237]

Proposed readiness dimension	Detailed description	Supporting readiness dimensions from the literature that apply to a health practitioner
Advocacy	Capacity for leadership and ownership of eHealth initiatives.	Ownership[238] Leadership[82, 83, 158, 244, 248] Leadership and collaboration[237] Management support[248, 255] Presence of a project champion[249]

4.3.5 Interviews and framework validation

A total of ten Australian nutrition informatics experts were interviewed. The practice areas represented included hospital (including management, clinical and foodservices) (4), research and education (2), private industry (2), government (1), and private practice/business (1). Many of the participants represented multiple practice areas, however for the purpose of this summary, only the primary practice area was noted.

The analysis of the interviews identified the same five themes as the literature review. The results of the interviews were summarised in a table based on their responses to each of the four questions, along with the percentage of authors from the literature review that identified each dimensions to allow a comparison (Table 4.3). Similarly to the authors included in the literature review, none of the nutrition informatics experts identified all five dimensions of eHealth readiness.

Once shown the framework however, all of the interviewees agreed on the included dimensions and felt they were relevant and equally important. All provided positive feedback about the framework and highlighted the usefulness in having this tool for the profession. Three interviewees discussed the use of the tool to prepare dietitians and related staff for eHealth projects within their organisation. In addition, two interviewees suggested the potential applicability to other allied health professionals.

One interviewee suggested to include ‘experience’ as part of aptitude. However, this was rejected, as this framework is about guiding the preparation of the profession for eHealth readiness. Inclusion of experience would suggest that dietitians who have not had eHealth experience are unable to be considered ready. All of the other dimension description suggestions were incorporated and the framework finalised (Figures 4.8 and 4.9).

A number of participants identified external factors that can influence dietitians in some of these dimensions, such as professional associations, political climate and education. However, the focus of this research was specifically on the professional group eHealth readiness dimensions, and consequently these external factors were also not included. Future investigations would be worthwhile to identify strategies to strengthen the capacity of each of these dimensions.

Table 4.3: eHealth readiness framework dimensions validation findings.

Proposed readiness dimension	Framework short description	Literature review dimensions identified (n=15)	Dimensions identified in interviews (Q1) (prior to seeing the framework)	Dimensions consensus in interviews (Q2) (after seeing the framework)	Dimension names and descriptions from interviews (Q3 & Q4) (after seeing the framework)
Access	Access to IT infrastructure and funding.	87% (n=13)	10% (n=1)	100% (n=10)	Add 'suitable eHealth solutions' (n=1).
Authority / Standards	Terminology and process standards.	53% (n=8)	30% (n=3)	100% (n=10)	Preferred 'Standards' over 'Authority' (n=10).
Attitude	Knowledge of the benefits of eHealth and willingness to utilise eHealth solutions.	71% (n=10)	80% (n=8)	100% (n=10)	Add 'awareness of what eHealth is' (n=2). Add 'awareness of the need to change' (level of frustration with existing solutions) (n=2).
Aptitude	Ability to utilise eHealth solutions.	43% (n=6)	70% (n=7)	100% (n=10)	Add 'experience' (n=1).
Advocacy	Capacity to lead eHealth initiatives.	53% (n=8)	50% (n=5)	100% (n=10)	Add 'communicate requirements' (n=1). Add 'capacity to support' (n=1). Add 'engage stakeholders' (n=1).

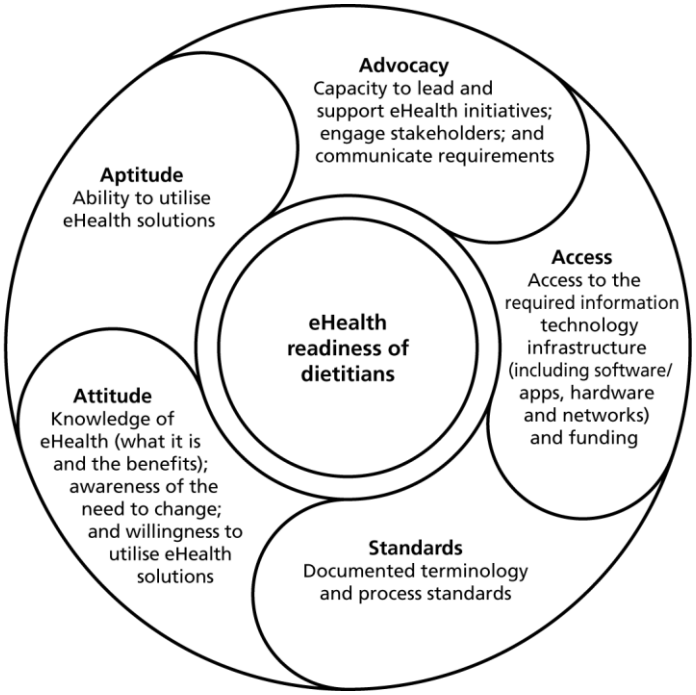


Figure 4.8: Framework for eHealth readiness of dietitians (FeRD) – black and white version.[257]

Figure 4.9: Framework for eHealth readiness of dietitians (FeRD) – coloured version.[257]

4.4 Discussion

There is a paucity of literature on eHealth readiness, and there were no frameworks identified for assessing and reporting on the eHealth readiness of allied health professionals (including dietitians). Consequently a SLR and interviews were conducted to inform the development of a framework for investigating the eHealth readiness of dietitians, which was abbreviated to FeRD. The FeRD uniquely identifies all relevant dimensions through an inductive approach, having selected all of the key themes from a variety of authors and experts, who listed areas of which they felt important, within the context of their focus setting or their experience. The findings of this study led to the development and validation of the first framework for eHealth readiness assessment for dietitians.

The results of the SLR and the interview responses highlight the complexity of eHealth readiness, specifically how different experiences and exposures to eHealth create different levels of knowledge and ideas with regard to what may be important for determining eHealth readiness. There was no single study (publication) or nutrition informatics expert interview respondent that identified all of the key dimensions. Whilst the most frequently reported dimension in the literature was *access* (87%), conversely this was the least reported by the nutrition informatics experts (10%). The reason *access* may not have been identified by nutrition informatics experts, is that Australian dietitians report high levels of access to technology in the workplace[258] and consequently it may be presumed that this group take it for granted.[259] Once all of the proposed dimensions were revealed during the interviews, they were all supported 100 percent. The results emphasise the importance of having a framework for guiding the profession to identify all of the essential dimensions, and not leave out any based on assumptions or experience, as every eHealth readiness assessment will be unique.

The FeRD will enable the assessment of readiness of dietitians at all levels, from single facilities or areas, to organisations, and even at the state or national level. It is

anticipated that this framework will be part of the preparation for the implementation of any eHealth solution for dietitians. Chapter 5 will describe a national eHealth readiness survey of Australian dietitians[259] which will be analysed using the FeRD, which is an example of how this framework can be applied to the profession at a national level. Using the FeRD to either develop assessment tools (such as a questionnaire) or review existing tools to ensure they assess all eHealth readiness dimensions, will enable the development of targeted improvement strategies for the profession.

An example of how the framework can be utilised at a facility or organisational level, is for the preparation of dietitians for the implementation of a nutrition-related eHealth solution. A specific case would be the implementation of a hospital patient electronic meal ordering solution for food and nutrition services which requires significant preparation and eHealth readiness of the end users (including dietitians). The ordering system requires institutional review, but individuals also require preparation. The FeRD provides a comprehensive methodology essential for identifying all relevant project requirements, and assists in developing preparation activities (such as education and in-services) to ensure increased success of the eHealth solution. As identified in the interviews reported here, dietitian readiness has multiple dimensions but some are potentially overlooked without the application of a framework.

This study was limited to the design and initial validation of the framework, with a small number of interview participants. Future studies utilising the FeRD will strengthen the validation of this framework, such as a hospital patient electronic meal ordering solution implementation. Future research could investigate the applicability of the FeRD to other allied health professionals, such as physiotherapists and occupational therapists.

The FeRD offers a comprehensive platform for the analysis and identification of areas for professional improvement to enable the benefits of eHealth to be realised and for the prevention of innovation failure. It provides a conceptual model for developing eHealth readiness evaluation tools to measure, examine and drive strategies to better prepare dietitians for eHealth. It may also prove relevant and useful to assess the eHealth readiness of other allied health professions. This framework builds on existing theories and assessment models of eHealth readiness and incorporates expert opinions, and consequently covers a comprehensive range of dimensions, including access, standards, attitude, aptitude and advocacy. The evaluation of dietitian readiness for eHealth should not be limited to acceptance and adoption of eHealth, but should cover all of the dimensions identified in this framework.

CHAPTER 5: NATIONAL DIETITIAN EHEALTH READINESS STUDY

* The majority of Chapter 5, including the data related to the comparison of the Australian 2013 and 2016 results has been submitted for peer review:
Maunder K, Williams P, Walton K, Ferguson M & Beck E. (2017). eHealth readiness of dietitians. *Journal of Human Nutrition and Dietetics*, 'revisions submitted'.

* The data related to the comparison of the Australian 2013 and US 2011 results has been published in a peer reviewed journal:
Maunder K, Williams P, Walton K, Ferguson M, Beck E, Hoggle L, Ayres E. (2015). Uptake of nutrition informatics in Australia compared to the United States of America, *Nutrition and Dietetics,* 72 (3):291-298.

* The key findings of the comparison of the Australian 2013 and 2016 results have been peer reviewed and presented at a conference and the abstract included in the following publication:
Maunder K, Walton K, Williams P, Ferguson M, Beck E. (2017). eHealth readiness of Australian dietitians. 34th National Conference of the Dietitians Association of Australia, Hobart. *Nutrition and Dietetics,* Vol 74 (Suppl. S1):10-11.

* The key findings of the comparison of the Australian 2013 and US 2011 results have been peer reviewed and presented at a conference and the abstract included in the following publication:
Maunder K, Walton K, Williams P, Ferguson M, Beck E, Hoggle L, Ayres E. (2014). 2013 Australian nutrition informatics survey. 31st National Conference of the Dietitians Association of Australia, Brisbane. *Nutrition and Dietetics,* 71(Suppl. S1):13-13

Amara's Law: *"We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run."*

Roy Charles Amara

Researcher, scientist and past president of The Institute for the Future (1925 – 2007)

5.1 Introduction

In order to prepare the dietetics profession to effectively practice in the digital age and keep up with consumer expectations, dietitian eHealth readiness must be determined. In addition, it is important to also understand if and how the profession is changing over time. Utilising this data will then enable professional development strategies to be targeted at the identified needs of dietitians, equipping them with the knowledge and skills to make informed decisions about how to utilise informatics to enhance practice. In addition, these studies sought to compare the Australian results to the Academy 2011 published survey results. Computer and Internet use and trends

of the general population of Australia and the US are comparable,[14,15] and there are similarities in their dietetic practice (eg. both utilise the NCPT), making these countries suitable for comparison.

There is no literature on Australian dietitian eHealth readiness and so the newly developed FeRD (Chapter 4), was utilised to comprehensively investigate the eHealth readiness of Australian dietitians over time.

5.1.1 Aim:

The aims of this study were:

- *To determine the eHealth readiness, and changes over time, of Australian dietitians; (Objective 3)* and
- *To identify the perceived barriers and enablers to dietitian eHealth readiness. (Objective 4)*

The objectives of these studies were to survey dietitians in Australia using the FeRD to:

1. Collect baseline data on Australian dietitian eHealth readiness, and compare the results to US dietitian eHealth readiness (using a comparable survey).
2. To assess dietitian eHealth readiness over time using the FeRD dimensions of access, attitude, aptitude and advocacy readiness.
3. To determine the educational support preferences for eHealth.

5.2 Methods

This research encompassed both a comparison of baseline 2013 Australian eHealth readiness data[259] to the published 2011 Academy results,[10] and a cross-sectional study of Australian dietitians, comparing the 2013[259] (baseline data) and 2016 results. A comprehensive assessment of the eHealth readiness of dietitians, and how and if the readiness has changed over time, will guide the development of strategies for improvement. Therefore, to allow a direct comparison to the situation in the US, the same survey as that developed by the Academy Nutrition Informatics Committee and

HIMSS Analytics was utilised. The questionnaire collected demographic information, educational support preferences, eHealth usage and assessed dietitian eHealth readiness.

The Academy Nutrition Informatics Committee was contacted in 2012 and the use of their survey with some modifications was approved.[260] Modifications to the survey to make it valid for use in Australia (namely to reflect Australian terminology), and to provide additional research data on perceived barriers and enablers that impacted on eHealth implementations were required. Questions relating to the IDNT, recently renamed the NCPT, were removed due to a comprehensive survey study on this topic already in progress in Australia.[261] The modified survey was circulated to the DAA HIAC for review and comment. The final revised survey instrument for assessing Australian dietitian eHealth readiness was piloted and tested for face and content validity by nine Australian dietitians. The final 30-item questionnaire was presented in multiple formats, including multiple-choice (17 questions), yes/no (6 questions), Likert scale (3 questions) and open-ended (4 questions) (Appendix H).

The same Australian dietitian eHealth readiness survey was utilised again in 2016, with some minor modifications. The further modifications to the survey included the removal of three questions and the addition of three questions. The questions on whether the respondent was a member of the Dietitians Association of Australia (DAA), the source of the survey (DAA, Dietitian Connection, colleague or other), and whether in the clinical setting patients make their own menu selections were removed as they were deemed not relevant for the analysis. The additional questions related to whether technologies were utilised and recommended during clinical patient interactions, and specifically which technologies were used. The additional questions were reviewed by the HIAC committee dietitians for face and content validity, with some minor wording changes incorporated. The 30-item questionnaire was presented in multiple formats, including multiple-choice (19 questions), yes/no (4 questions), Likert scale (3 questions) and open-ended (4 questions) (Appendix I).

The FeRD (developed in Chapter 4), which encompasses five dimensions of eHealth readiness: access, standards, attitude, aptitude and advocacy (Figures 4.8 and 4.9), was utilised to analyse the survey questions. Each of the 30 questions was linked to a corresponding framework dimension (Appendix J). Although NCPT is referred to in the survey questions, questions relating specifically to NCPT or 'standards' as the fifth dimension were not included in the survey questions, as these are well documented and accepted international dietetic standards and process terminology.[112, 262]

Ethics approval was granted (HE13/274) by the University of Wollongong Human Research Ethics Committee. The DAA disseminated the survey electronically to members on two occasions, three weeks apart, in both mid-2013 (to 5,032 members) and again in mid-2016 (to 6,221 members) via links from the national newsletter and also direct emails to several DAA interest groups. The survey was also advertised through a professional nutrition organisation's e-newsletter in mid-2013 and mid-2016.[263] A paper survey version was available for those less comfortable with technology and utilising online tools, to prevent under-representation of this group. A prize incentive was offered on both occasions to a random participant to encourage survey participation and to entice dietitians that may not usually be interested in eHealth involvement. The invitation to participate was open for one month. SurveyMonkey® (an online survey tool) was used to collect survey responses. The Academy survey conducted in 2011 was distributed to 64,751 members.

Statistical analysis was performed using SPSS software (version 23, 2015, SPSS Inc., Chicago, IL, US). Descriptive statistics (mean, median, count and percentages), Independent *t*-tests, Chi-square tests and z-tests were used to investigate the association between demographics and dietitian responses, age groups and dietitian responses and to compare 2013 and 2016 responses. The level of significance was set at $p<0.05$, and for Chi-square tests with multiple testing a Bonferroni adjustment was performed and the level of significance was lowered to $p<0.003$, due to the increased risk of a Type 1 error.

5.3 Results

The survey including a combination of compulsory and optional questions/answers. Consequently, some of the response rates will be different for the different questions. In addition, some questions allowed for the selection of multiple answers, and thus the total may add up to more than 100%.

5.3.1 Australian dietitians 2013 compared to US dietitians 2011

For the purpose of this analysis, the survey findings from the 2013 Australian survey were compared to the published 2011 Academy survey results.[10] The survey completion rate was 15% (747 respondents), representing DAA members with a 95% confidence level and a confidence interval of 3.3. The Academy 2011 survey completion rate was 5% (3,342 respondents), representing Academy members with a 99% confidence level and a confidence interval of 2.2. All responses were electronic for both the DAA and Academy surveys. Forty-six percent of Australian respondents were familiar with the term nutrition informatics. This question was not included in the Academy survey.

5.3.1.1 Demographics

Demographic characteristics of Australian and Academy respondents are outlined in Table 5.1. There was a significant difference in the gender and age distribution of Australian and Academy respondents ($p<0.001$).[10] However, females represented the majority of both the Australian (94%) and Academy respondents (96%). The majority of Australian respondents (30%) were in the 25-29 year category, compared to the majority of Academy respondents (48%) being greater than 50 years.[10]

All DAA defined practice areas were represented, and there was no significant difference in the reported practice areas, and the majority of respondents represented the practice area of clinical nutrition for Australia (41%) and the Academy (43%) ($p=0.334$).[10] Australian responses were received from all States and Territories and this was representative of DAA membership ($p=0.260$).

Table 5.1: Demographic characteristics of Australian and Academy respondents

	Australian dietitians 2013 % (n=747)	**Academy dietitians 2011** % **(**n=3,342)	**P value**
Gender (%)			<0.001*
Female	94	96	
Male	5	3	
Prefer not to answer	1	1	
Age (%)			<0.001*
Under 25 years	10	6	
25-29	30	11	
30-34	16	9	
35-39	11	6	
40-44	11	8	
45-49	6	10	
50-54	7	17	
55-59	4	19	
60-64	2	9	
65 years or older	1	3	
I prefer not to answer	1	1	
Practice Area (%)			0.084
Clinical nutrition	41	43	
Community and public health	17	14	
Consultation and business/private practice	12	9	
Education	3	8	
Research	6	3	
Foodservice	3	NA	
Food industry	2	NA	
Informatics	1	1	
Dietetic student	3	7	
Mixed practice (3+ areas of work)	8	NA	
Food and nutrition management	NA	9	
Retired	0	NA	
Do not work in nutrition and/or dietetics	1	NA	
Other	3	7	

#NA = not available *z-test used to determine significance of difference ($p<0.05$ = significant)

5.3.1.2 Use of HIT

Australian and Academy responses to electronic data accessed are outlined in Table 5.2. The top ten data types accessed electronically were the same for the Australian

and Academy[10] respondents, although in a slightly different order, with a higher level of electronic access to all of the top ten data types by Australians ($p<0.01$). Interestingly, as well as being reported in the top 10 to be accessed electronically, CPD was still highly rated by the Australian and Academy respondents for access by direct interaction (70%, 53% respectively).

Table 5.2: Data accessed electronically by Australian and Academy respondents

Area	Australia 2013		Academy 2011		P value
	n	%	n	%	
Continuing professional education	671	95.9%	2607	78.0%	<0.001*
Evidence-based library	660	94.3%	2620	78.4%	<0.001*
Professional journals	660	94.0%	2583	77.3%	<0.001*
Patient educational materials	620	88.6%	2724	81.5%	0.514
Nutrient database	608	87.1%	2710	81.1%	0.804
Recipes/menus	591	84.3%	2533	75.8%	0.069
Standards of practice	562	81.0%	2232	66.8%	<0.001*
Drug data/information	556	79.8%	2363	70.7%	0.060
Lay literature	552	80.2%	2443	73.1%	0.621
Patient data from other professionals	531	76.5%	2232	66.8%	0.031
Schedules	527	76.0%	2029	60.7%	<0.001*
Data/information from patients and clients	508	73.0%	NA	NA	NA
Work load statistics	508	72.7%	1417	42.4%	<0.001*
Social media (i.e. social networking sites, blogs)	460	66.2%	1965	58.8%	0.162
Standardised Terminology (i.e. NCPT)	454	65.2%	1972	59.0%	0.365
Diet manual/nutrition care manual	406	58.2%	NA	NA	NA
Project management	393	56.5%	NA	NA	NA
Purchasing	301	43.1%	NA	NA	NA
Billing	245	35.1%	1053	31.5%	0.494
Budget	239	34.4%	952	28.5%	0.061
Textbooks	203	29.1%	829	24.8%	0.172
Inventory	155	22.5%	NA	NA	NA
Sales	118	17.1%	NA	NA	NA

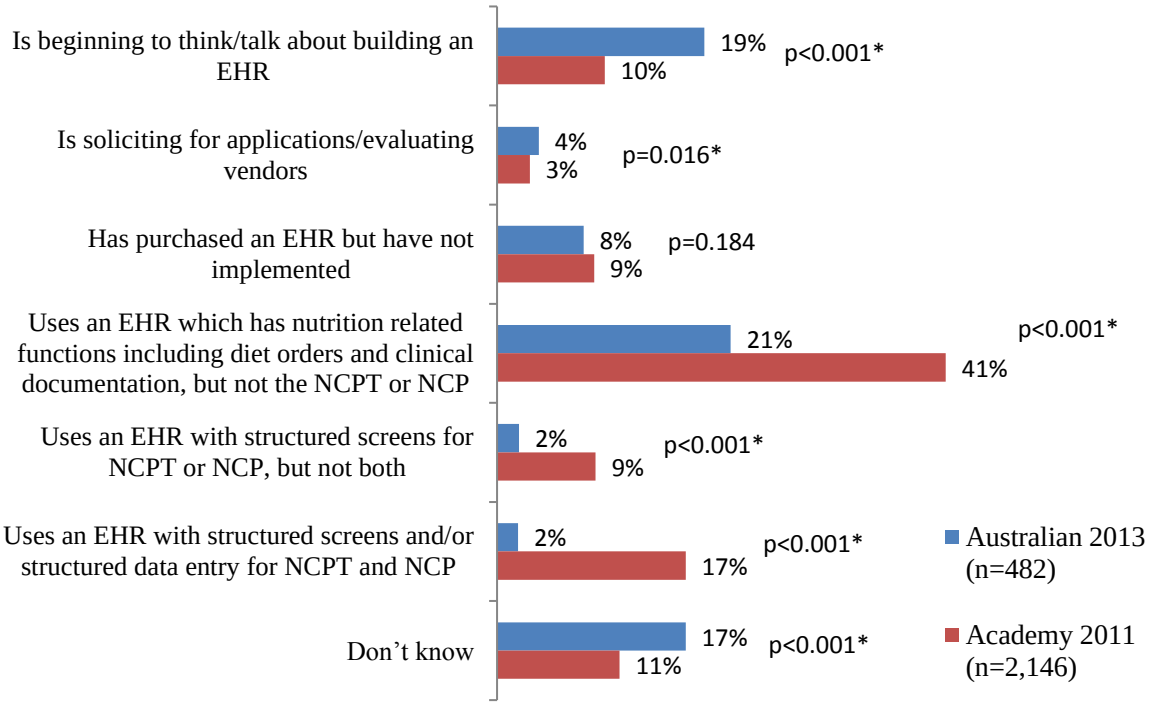
NA = not available *z-test used to determine significance of difference ($p<0.05$ = significant)

5.3.1.3 Accessibility readiness

Ninety eight percent of Australian and 97% of Academy[10] respondents reported having access to electronic data in their workplace or to support their educational

pursuits. Access was evenly reported across the practice areas. Similar responses to the Academy[10] were also reported when Australian dietitians were asked how they accessed electronic data. Within the workplace, eighty three percent had access to a dedicated computer, 34% to a shared workstation, 31% to a mobile device and 5% to a smart board. For educational purposes, 97% had a dedicated computer (88% personally-owned and 8% University provided), 45% accessed a mobile device, 25% a shared workstation, and only 2% utilised a smart board.

Figure 5.1 outlines the level of integration of the EHR within organisations (where relevant) by Australian and Academy respondents. Significantly more (67%) Academy respondent organisations had implemented an EHR compared to 25% of Australian respondent organisations ($p<0.001$). Of those respondents using an EHR, significantly more Academy respondents (40%) are accessing structured data for the NCPT compared to Australian respondents (15%) ($p<0.001$).



* z-test used to determine significance of differences (p<0.05 = significant)

Figure 5.1: Comparison of 2013 Australian and 2011 Academy responses to the question on the level of integration of the EHR within their organisation.

5.3.1.4 Attitudinal readiness

Similar Australian and Academy responses were received to '*I use data and technology available to me to problem solve*' (Figure 5.2) and '*I use data and technology available to me for decision making*' (Figure 5.3). On a Likert scale of one to five, where one is 'strongly disagree' and five is 'strongly agree', Australian respondents recorded an average score of 4.22 related to problem solving and an average score of 4.03 related to decision making. Responses were evenly distributed across the practice areas and between questions, with the exception of dietetic students, mixed practice and consultation and business/private practice. Within these three practice areas, respondents were significantly more likely to agree with the comment on problem solving (95%, 80% and 80% respectively) compared with the comment on decision making (79%, 69% and 63% respectively) (all p<0.05). Very similar results were reported by the Academy [147] relating to using data and

technology for problem solving with an average score of 4.17, and for using data and technology for decision making with an average score of 4.03.

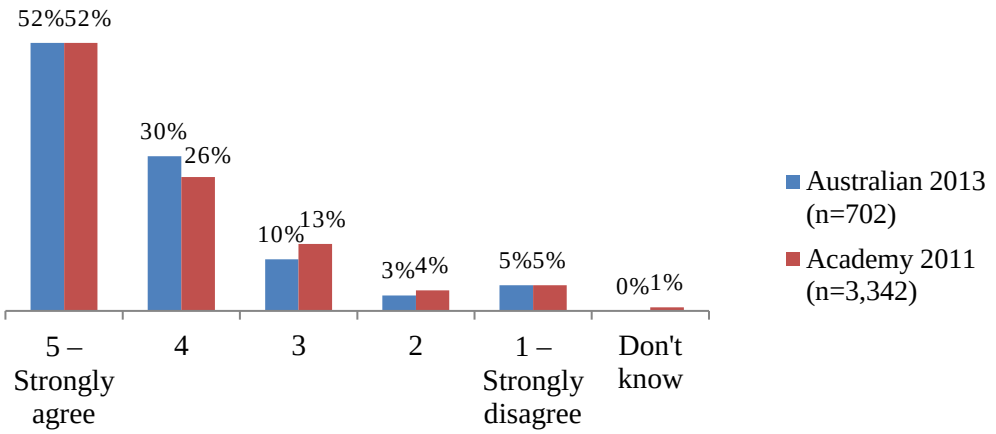


Figure 5.2: Comparison of 2013 Australian and 2011 Academy responses to the question '*I use data and technology available to me to problem solve*'.

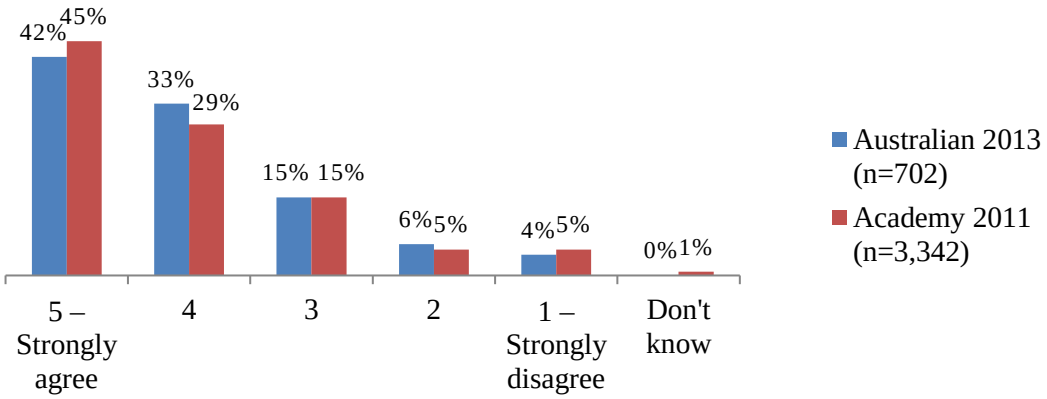
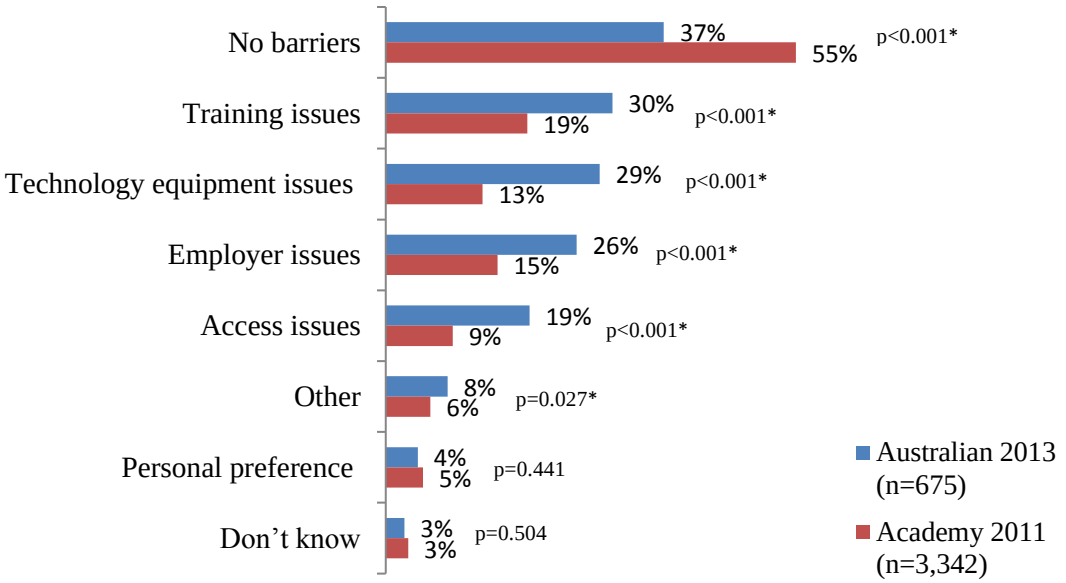


Figure 5.3: Comparison of 2013 Australian and 2011 Academy responses to the question '*I use data and technology available to me for decision making'*.

Australian and Academy[10] respondents reported that HIT can positively impact time management and improve the ability to access and analyse data (>50%), and were less likely to believe that HIT can improve patient safety, the quality of care and reduce medical errors (<44%). Of the Australian respondents, 93% reported improved access to research/education material, 71% enhanced time management and 69% improved access to patient data. These areas, along with others directly

impacting on daily dietetic work activities (such as improved workflow efficiency and improved communication) were selected by greater than 50% of respondents. However, similar to the Academy,[10] the areas related to higher organisational and patient outcomes had less percentage of respondents, being only 40% improved patient safety/quality of care and 22% reduction/prevention of medical errors.

'No barriers' to using technology was reported by 37% of Australian and significantly more (55%) of Academy[12] respondents ($p<0.001$) as outlined in Figure 5.4. Of the Australian respondents reporting 'no barriers' 80% were from the practice area of informatics, 60% from the food industry and 50% from research. In addition, there were 26-30% of Australian responses reporting barriers of training, employer issues and technology equipment issues compared to less than 20% reported by the Academy.[10]



* z-test used to determine significance of differences ($p<0.05$ = significant)

Figure 5.4: Comparison of 2013 Australian and 2011 Academy responses to the question on barriers: 'What are the reasons/barriers (personal or work related) for not using information technology in your practice or for your education needs?'

5.3.1.5 Aptitudinal readiness

Eighty one percent of Australian respondents reported a high level of experience retrieving and accessing electronic data. The greatest percentage of a high level experience rating was reported by respondents working in informatics (100%) followed by education (90%). Only 1% of respondents classified themselves as having low levels of experience with access and retrieval of electronic data. The Australian participants reported significantly higher experience retrieving and accessing electronic data than the Academy respondents[10] ($p<0.001$). A higher percentage of highly experienced ratings was reported by respondents working in informatics (60%) or education (60%).

However, 77% of Australian respondents had no experience with a nutrition-related IT system implementation in their practice area. There were significant differences in the responses between practice areas, with 60% from informatics and 52% from foodservices reporting the highest percentage of experience, while the remainder ranged from 40% to as low as 6% ($p<0.001$). The Academy survey did not include this question.

The baseline ratings related to comfort levels were very similar between the Australian and Academy[12] responses, with eight of the top ten expert ratings the same, including word processing (53%, 46%), slide presentations (45%, 34%) and web/Internet (39%, 37%) respectively. Respondents rated themselves as a beginner for statistical analysis (32%), using web authoring tools (23%), creating pod casts (21%) and using graphics (21%).

5.3.1.6 Advocacy readiness

Reflecting the low levels of experience with nutrition-related IT system implementations, Australian respondents reported low levels of organisational involvement with HIT. Table 5.3 outlines the organisational roles in HIT by

Australian and Academy respondents for which there was an overall significant difference ($p<0.001$).

The Australian responses reported slightly more involvement in daily activities (end-user activities) compared to scoping and developing stage activities. As may have been expected, a higher percentage (35%) of consultation and business/private practice respondents reported being a decision maker across the involvement areas, significantly higher than the average of all practice areas ($p<0.001$).

Table 5.3: Organisational roles in HIT by Australian and Academy respondents

	Australian 2013 (n=669)			Academy 2011 (n=3,342)			P value
	Decision maker %	**Makes recommendations %**	**No role %**	**Decision maker %**	**Makes recommendations %**	**No role %**	
Project management	18	35	47	11	32	56	<0.001*
Change management	15	44	41	11	41	48	0.001*
Database management	12	27	61	9	31	61	0.030
Mobile computing device	10	15	75	7	15	78	0.007
Software selection	9	25	66	9	31	60	0.008
Software implementation	9	18	73	9	24	67	0.002*
Social media sites managing	8	9	82	NA	NA	NA	NA
Data standards	8	22	69	8	29	63	0.002*
Workflow design	8	20	71	8	28	63	<0.001*
Software training	8	18	74	9	24	66	0.001*
Hardware selection	8	19	73	6	21	73	0.045
Web-site management	7	14	79	6	18	75	0.038
Developing terminology	7	22	72	6	29	65	0.001*
Web-site development	6	16	78	6	22	72	<0.001*
Software support and maintenance	6	12	82	6	17	76	0.470
Interfacing systems	5	10	85	4	17	79	<0.001*
Software enhancement/optimisation	4	15	81	5	21	75	0.001*
Software development	3	9	88	3	14	83	0.003*
Average	8	19	73	11	41	48	<0.001*

* $\chi 2$ test used to determine significance of differences (Bonferroni adjustment performed and significance lowered to $p < 0.003$, due to the increased risk of a Type 1 error with multiple testing) between the roles across the two survey cohorts.

5.3.1.7 Educational support preferences for eHealth

Professional development (77%, 81%), training (69%, 63%) and resource materials (69%, 80%) were the top three methods selected for helping support the use of HIT for daily activities by Australian and Academy[10] respondents respectively.

5.3.2 Australian dietitians 2013 compared to Australian dietitians 2016

For the purpose of this analysis, the survey findings from the 2016 Australian survey were compared to the published 2013 Australian survey results [259]. The survey completion rate in 2013 was 15% (747 respondents), representing DAA members with a 95% confidence level and a confidence interval of 3.3. The survey completion rate in 2016 was 7% (417 respondents), representing DAA members with a 95% confidence level and a confidence interval of 4.6. All responses were electronic for both surveys.

The survey completion rate in 2013 was 15% (747 respondents), representing DAA members with a 95% confidence level and a confidence interval of 3.3. The survey completion rate in 2016 was 7.0% (417 respondents), representing DAA members with a 95% confidence level and a confidence interval of 4.6.

5.3.2.1 Demographics

Demographic characteristics of respondents (Table 5.4) showed no significant difference in the gender, age distribution or practice area of the 2013 and 2016 respondents ($p>0.05$). Females represented the majority of the respondents, and the 25-29 years category represented the largest group of respondents. All DAA defined practice areas were represented, and there was no significant difference between 2013 and 2016 ($p=0.189$), with a high proportion of respondents from the practice area of clinical nutrition. Responses were received from all Australian States and Territories and this was representative of DAA membership for both 2013 and 2016 ($p=0.260$).

Table 5.4: Demographic characteristics of 2013 and 2016 respondents.

	2013 (n=747) %	**2016** (n=417) %	**P value**
Gender (%)			0.593
Female	94	96	
Male	5	4	
Prefer not to answer	1	0	
Age (%)			0.025*
Under 25 years	10	7	
25-29	30	25	
30-34	16	15	
35-39	11	15	
40-44	11	13	
45-49	6	9	
50-54	7	6	
55-59	4	5	
60-64	2	3	
65 years or older	1	1	
I prefer not to answer	1	1	
Practice Area (%)			0.189
Clinical nutrition	41	36	
Community and public health	17	15	
Consultation and business/private practice	12	17	
Education	3	3	
Research	6	8	
Foodservice	3	4	
Food industry	2	3	
Informatics	1	1	
Dietetic student	3	2	
Mixed practice (regularly undertaking 3+ areas of work)	8	9	
Retired	0	0	
Do not work in nutrition and/or dietetics	1	0	
Other	3	2	

* z-test used to determine significance of differences ($p<0.05$ = significant)

5.3.2.2 Use of HIT

Out of the 23 data types accessed electronically, the top nine (evidence-based library, professional journals, CPD, patient education materials, recipes and menus,

schedules, nutrient database, standards of practice, and social media) were the same in 2013 and 2016 (p=0.968). Interestingly, as well as being reported in the top nine to be accessed electronically, CPD was still highly rated by the 2013 and 2016 respondents for access by direct interaction (70%, 69% respectively).

Three new questions introduced in 2016 relating to methods utilised for patient consultations were not compulsory, so the results are from the analysis of 310 responses, as there were 72 excluded (those that do not conduct patient consultations) from the total of 382 (Table 5.5). The majority of responses to each of these questions were utilising a traditional approach rather than utilising technology, with: 95% of the respondents who conduct patient consultations offering face-to-face; 79% of respondents for the documentation and analysis of patient data during consultations using paper; and 83% of respondents recommended paper records to patients to assist them in their nutrition data collection and monitoring.

The answers to the use of technology in a clinical setting were influenced by the age of the respondent (Table 5.5). Comparing dietitians less than 35 years (Gen Z and Gen Y) to those over 35 years of age (Gen X and Baby Boomers) provided interesting insight into their different approaches to support clinical consultations. Significantly more dietitians under 35 years use software/computer programs to document and analyse patient data (p=0.002), and recommend mobile device apps to patients to monitor and collate their nutrition data (p=0.044). The analysis of this data was from only 284 responses, comprised of those from respondents who provided an answer to the question on age (n=356), excluding the 72 who do not conduct patient consultations.

Table 5.5: Methods utilised for patient consultations by 2016 respondents.

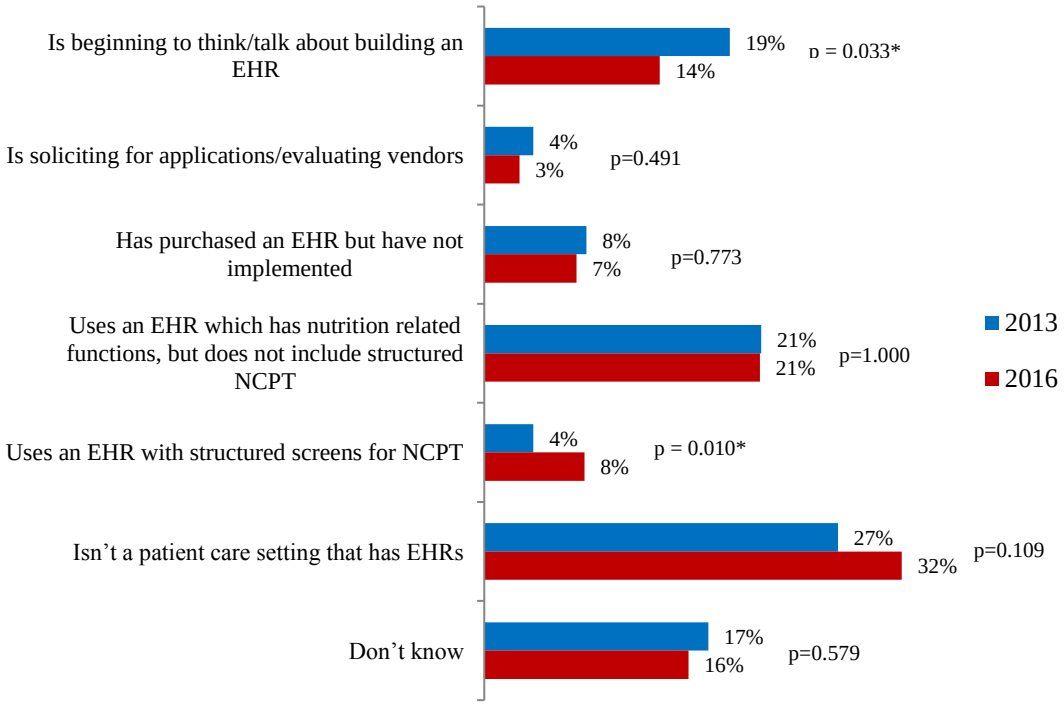
	2016 (n=310) %	**< 35 years** (n=140) %	**≥35 years** (n=144) %	**P value**
What methods for patient consultations do you offer?				
Face-to-face	95	96	95	1.000
Phone	57	59	54	0.453
Email	28	26	30	0.517
Video (eg. Skype or videoconferencing)	19	23	15	0.140
Which of the following methods do you use for documenting and analysing patient data during patient consultations?				
Paper	79	72	81	0.126
Software/computer programs (eg. Kalix, FoodWorks)	59	68	49	0.002*
Mobile device apps (eg. eNutrition, Dietitian's App)	20	19	22	0.643
What do you recommended to patients for assisting in their nutrition data collection or monitoring?				
Paper records	83	85	79	0.205
Mobile device apps (eg. MyFitnessPal)	74	79	68	0.044*
Mobile devices (eg. FitBit)	39	41	37	0.499
Software/computer programs	24	23	24	0.992

* z-test used to determine significance of differences ($p<0.05$ = significant)
NB. Respondents could select more than one answer option.

5.3.2.3 Accessibility readiness

Ninety-nine percent of respondents in both 2013 and 2016 reported having access to electronic data in their workplace. Access was evenly reported across all the practice areas. Similar responses between 2013 and 2106 were also reported when dietitians were asked how they accessed electronic data. Within the workplace, 83% (2013) and 86% (2016) had access to a dedicated computer (p=0.16); 34% (2013) and 35% (2016) to a shared workstation (p=0.82); 31% (2013) and 41% (2016) to a mobile device (p=.001); and 5% (2013) and 6% (2016) to a smart board (p=0.52).

Figure 5.5 outlines the level of integration of the EHR within organisations by 2013 and 2016 respondents. Whilst there has been in a significant decrease in organisations discussing an EHR solution (p=0.033), those soliciting, purchasing and utilising an EHR has remained the same (p=0.491). Of most interest is that the use of structured screens within the EHR for NCPT has increased significantly (p=0.010). The analysis is based on 364 responses to this question.



* z-test used to determine significance of differences (p<0.05 = significant)

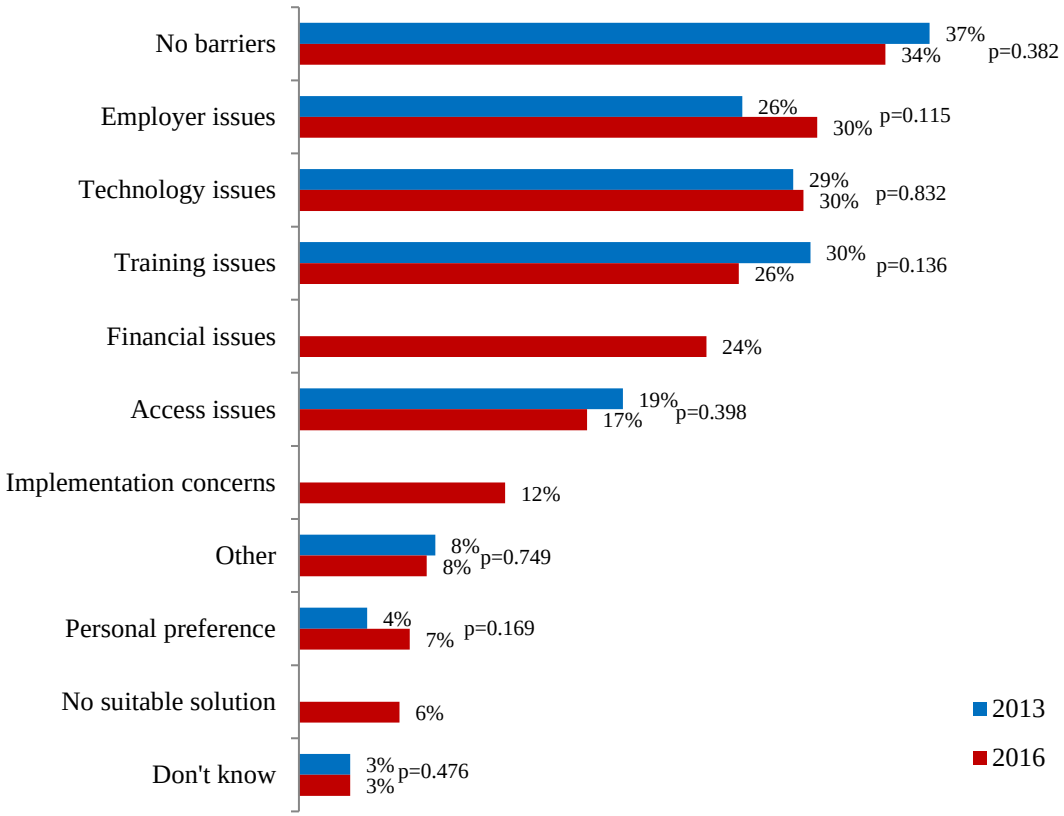
Figure 5.5: Comparison of 2013 and 2016 responses to the question on the level of integration of the EHR within their organisation (n=364).

5.3.2.4 Attitudinal readiness

Similar responses were received to the statements '*I use data and technology available to me to problem solve*' and '*I use data and technology available to me for decision making*' from 2013 and 2016 respondents. On a Likert scale of one to five, where one is 'strongly disagree' and five is 'strongly agree', respondents reported no significant changes related to problem solving (4.22 (2013) and 4.25 (2016)) (p=0.89) and decision making (4.03 (2013) and 4.04 (2016)) (p=0.40).

Respondents from both 2013 and 2016 reported that IT benefits them in relation to their daily dietetic work activities, including improving access to research and education materials (93%, 89%), improved access to patient data (69%, 74%) and enhanced time management (71%, 74%). Similarly in both surveys, respondents were less likely to report that eHealth can improve patient safety/quality of care (40%, 44%) and reduce medical errors (22%, 32%). A new potential benefit was added in the 2016 survey, 'increase patient engagement in managing their health', which only received agreement from 37% of respondents. The only significant change, between the two surveys was an increase from 22% to 32% in the belief that eHealth can reduce medical errors ($p=0.001$). There was no significant difference in the responses based on age ($p>0.05$).

'No barriers' to using technology was reported by 37% of 2013 and 34% of 2016 respondents, with no significant differences in any of the identified barriers ($p=0.382$) (Figure 5.6). Three new barriers of 'financial issues', 'implementation concerns' and 'no suitable solution' were added in 2016, and consequently there is no data from 2013 for comparison. Of the respondents reporting 'no barriers', there was no significant difference in responses based on age ($p=0.091$).



* None of the differences were significantly different, using the $\chi 2$ test to determine significance of differences ($p<0.01$ = significant, due to the increased risk of a Type 1 error with multiple testing)

Figure 5.6: Comparison of 2013 and 2016 responses to the question on barriers: 'What are the reasons/barriers (personal or work related) for not using information technology in your practice or for your education needs?' (n=372)

Forty-six percent of Australian respondents were familiar with the term nutrition informatics in 2013, increasing significantly to 55% in 2016 (p=0.010).

5.3.2.5 Aptitudinal readiness

Eighty-one percent of 2013 respondents reported a high level of experience retrieving and accessing electronic data, which increased significantly to 87% in 2016 (p=0.007). Only 1% of 2013 and 0% of 2016 respondents classified themselves as having low to no levels of experience with access and retrieval of electronic data.

The ratings related to comfort levels were very similar between the surveys, with eight of the top ten 'expert' ratings the same, including word processing (53%, 57%), slide presentations (45%, 49%) and web/Internet (39%, 39%) respectively. The percentage of respondents reporting themselves as experts increased significantly for webinars and spreadsheets (both $p<0.05$). Respondents rated themselves as a 'beginner' for statistical analysis (32% and 33%), using web authoring tools (23% and 20%), and creating pod casts (21% and 20%) in 2013 and 2016 respectively. The tasks of Internet, social media and webinars received significantly more expert ratings by dietitians less than 35 years to those aged 35 years or older ($p<0.001$, $p<0.001$ and $p=0.001$ respectively).

There was a significant increase in the number of respondents who reported having no recent experience with a nutrition-related IT system implementation in their practice area (77% in 2013 and 83% in 2016, $p=0.02$). There was no significant difference in the responses based on age ($p=0.118$).

5.3.2.6 Advocacy readiness

Australian respondents continue to report low levels of organisational involvement in eHealth. Organisational roles in eHealth by 2013 and 2016 respondents, demonstrates that the majority of dietitians report 'no role' (73% in 2013 and 61% in 2016), followed by 'makes recommendations' (19% in 2013 and 23% in 2016), and finally 'decision maker' (8% in 2013 and 16% in 2016) (Table 5.6). However, whilst the highest percentage still report 'no role', there is a significant improvement in roles across all activities, with 'no role' decreasing and both 'makes recommendations' and 'decision maker' increasing from 2013 to 2016 ($p<0.001$) (Table 5.6). A significantly higher proportion of dietitians are reporting being the 'decision maker' and 'making recommendations' for project management and change management in 2016 compared to 2013 ($p<0.001$ and $p=0.009$ respectively).

Table 5.6: Organisational roles in eHealth by Australian 2013 and 2016 respondents.

	Australian 2013 (n=669)			Australian 2016 (n=369)			P value
	Decision maker %	Makes recommendations %	No role %	Decision maker %	Makes recommendations %	No role %	
Project management	18	35	47	26	40	34	<0.001*
Change management	15	44	41	20	49	31	0.009*
Database management	12	27	61	24	33	43	<0.001*
Mobile computing device	10	15	75	21	20	59	<0.001*
Software selection	9	25	66	17	30	53	<0.001*
Software implementation	9	18	73	16	24	59	<0.001*
Social media sites managing	8	9	82	21	21	58	<0.001*
Data standards	8	22	69	16	27	56	<0.001*
Workflow design	8	20	71	16	28	56	<0.001*
Software training	8	18	74	15	22	62	<0.001*
Hardware selection	8	19	73	16	22	62	<0.001*
Web-site management	7	14	79	16	17	67	<0.001*
Developing terminology	7	22	72	12	25	63	0.009*
Web-site development	6	16	78	15	22	63	<0.001*
Software support and maintenance	6	12	82	15	14	71	<0.001*
Interfacing systems	5	10	85	10	16	74	<0.001*
Software enhancement/optimisation	4	15	81	10	18	72	0.001*
Software development	3	9	88	8	12	80	0.002*
Other	1	3	97	7	4	89	<0.001*
Average	8	19	73	16	23	61	<0.001*

* $\chi 2$ test used to determine significance of differences (Bonferroni adjustment performed and significance lowered to $p < 0.003$, due to the increased risk of a Type 1 error with multiple testing) between the roles across two survey cohorts.

The answers to the levels of organisational involvement were only influenced by the age of the respondent for change management. Unsurprisingly, dietitians over 35 years of age were more likely to be the decision maker in relation to change management (p=0.01).

5.3.2.7 Educational support preferences for eHealth

There were no significant differences in educational support preferences between respondents in 2013 and 2016 (all p>0.05). Professional development (79%, 80%), training (76%, 75%) and resource materials (73%, 71%) were the top three methods selected for receiving help to support the use of eHealth for daily activities in 2013 and again in 2016.

5.4 Discussion

5.4.1 Australian dietitians 2013 compared to US dietitians 2011

The survey results, whilst two years apart, demonstrate that dietitians in Australia are similar to their US colleagues in their high level of comfort using technology, awareness of HIT workplace benefits, and low levels of organisational involvement in HIT management. Of great interest is that both respondent groups believe HIT can positively impact time management and improve the ability to access and analyse data, probably because these affect their daily work operations. However, both were less likely to believe that HIT can improve patient safety, quality of care and reduce medical errors, despite the mounting evidence.[2-7] Perhaps these organisational and patient focused outcomes were poorly recognised by dietitians, as this data is collected by the organisation and are more difficult to link to specific interventions.

While similar in some areas, Academy respondents were significantly more advanced in their level of integration of the EHR and involvement with HIT within their organisation. The significant differences in the implementation status of EHR, which was reported by 67% of Academy respondents compared to the 25% of Australian respondents is reflective of the far more recent introduction of EHRs into the Australian healthcare system.[264] Whilst the adoption rates of EHR are much higher in the US than Australia, the percentage of respondents who reported working in facilities with an EHR, are much higher than the national average for each

country. As outlined in section 1.2.4, the US adoption of a basic EHR is much higher than Australia. The US EHR adoption at the time of the Academy survey (2011) was 28%, and in Australia two years later, at the time of the national survey (2013) was <10%.[65-67] The trend in this area will be interesting to monitor as EHR implementations increase in Australia.

Another significant difference was that more Academy respondents reported no barriers to using HIT. Australians reported higher levels of training, technology equipment, employer and access issues. The reported differences may be a reflection of the progressive Academy education initiatives. Along with developing nutrition informatics competencies, the Academy has developed training programs in informatics and HIT sessions at conferences. Interestingly, 19% of Australian respondents listed 'access' as a barrier to using HIT, contradicting the responses to the question specifically on access to technology where 97% of Australians had access to a computer in the workplace (83% dedicated computer). Respondents who selected access issues as a barrier may have been referring to access to suitable software or applications rather than hardware, and consequently a question to distinguish between software and hardware access would be useful in future surveys.

Although the general populations of Australia and the US have comparable computer and Internet use and trends and similarities in their dietetic practice, the findings also highlight unique differences. Consequently, the survey may be generalisable to the rest of the dietetic population within each country and should be utilised to guide country specific eHealth education and support, other countries would be encouraged to conduct surveys for their unique baseline data.

5.4.2 Australian dietitians 2013 compared to Australian dietitians 2016

This is the first comprehensive study of the eHealth readiness of dietitians in Australia, providing baseline data, as well as indicative trends over time. It is also the first study to utilise the FeRD to model an assessment tool and evaluate the results. Utilising the FeRD to analyse the survey responses, and the literature for standards, demonstrated a moderate level of readiness with minor improvements over time by Australian dietitians. Utilising the FeRD for the analysis, also enabled the specific

dimensions for improvement to be identified. Dietitians in Australia have well established practice standards (*standards*) and are progressing well in relation to *access* to eHealth (particularly via mobile devices, but need to improve the NCPT integration in EHRs). For *attitude* and *aptitude*, there is a moderate level of preparedness, with minor improvements over time. Dietitians reported being confident with using technology, but had yet to gain experience with eHealth implementations. While there was a good awareness of the benefits and risks that relate to dietetic activities, the complexity of eHealth and larger benefits to patient safety, quality of care and reduction in medical errors were yet to be realised. Broadly, they continue to rate poorly in relation to *advocacy* readiness, reporting minimal leadership in nutrition-related eHealth initiatives. However, in the context of Australian eHealth still being in the initial stages, dietitians are on the right path and anecdotally further advanced than other allied health professions. With the implementation of targeted strategies, dietitians will have the opportunity to become ready for eHealth, and become leaders amongst the allied health professionals.

With NCPT as an international standard of practice being integrated into clinical healthcare terminology products (such as SNOMED-CT), dietitians are well positioned in the area of *standards*. The survey findings report almost all dietitians (86%) had access to a dedicated computer, with 41% (a significant increase of 10% from 2013) having access to a mobile device in the workplace. Whilst EHR implementations remain low amongst respondents, there was a significant increase in the use of structured screens for nutrition care, the result of dietitians being well prepared with standardised terminology (NCPT).[265]

The assessment of dietitian *attitudes* showed no significant change over time. Whilst they continue to strongly agree that technology positively impacts on their daily work activities, they remain less convinced of the broader benefits to the patient and organisation (such as improving patient safety and quality of care, and reducing medical errors). These results may be due to the lack of awareness, as this data is collected by the organisation as opposed to a dietetic department. However, these larger organisational and patient benefits underpin the rationale of eHealth, and an improved awareness by dietetics could strengthen business cases to implement

nutrition-related HIT solutions, and also provide opportunities to analyse data to link nutrition intervention to patient outcomes. For example, a study by Rossi et al (2013) demonstrated the utilisation of an electronic system for documenting NCPT resulted in significant improvements in the efficiency of nutrition care and effectiveness related to patient outcomes.[141] Similarly, the barriers reported remained consistent between the surveys, with the top three (employer issues, technology issues and training issues) being reported by 26-30% respondents, and 'no barriers' continuing to be reported by only 34%.

Dietitians' *aptitude* remains high, self-reporting a high level of experience and comfort level accessing and utilising electronic data. However, this is limited to standard software solutions such as Word, PowerPoint and statistical analysis. With larger more complex nutrition-related IT system implementations, experience remains very low, with 83% of respondents reporting no experience. Consistent with the low levels of experience with nutrition-related IT system implementations, Australian respondents continue to report low levels of *advocacy* (organisational involvement) in eHealth initiatives. There are several possible reasons for this finding, including: the lack of experience dietitians have with implementations they may not feel confident to lead these projects; they may not feel it is a priority over their existing workload; and they are likely not to realise the importance of advocacy to the success of the final HIT solution. In addition, organisational engagement would only require dietetic representation, not all dietetics staff, which may also account for the lower numbers reported being involved. Further research to investigate the reasons for low level of advocacy and distinguish between the presence or absence of dietetic engagement on projects, versus individual engagement would be beneficial.

Comparing responses by respondent age demonstrated that whilst access and attitudes amongst dietitians were similar, eHealth usage, aptitude and advocacy had some significant differences. Dietitians less than 35 years old reported a higher level of comfort using some HIT solutions, and those over 35 years reported more involvement as the decision maker in change management. With this information, and knowledge that all age groups were less aware of the broader and larger benefits

of eHealth, relying on technical comfort and skills of the next generations will not be a sufficient strategy to ensuring eHealth readiness for our future. Those with the power to make change may underestimate the capabilities and ease of use of the technologies. This evidence reinforces the importance of having a framework to assess eHealth readiness of health professionals, and provide insight into the areas for improvement.

The survey response rates were low, and much lower in 2016 (7%) than in 2013 (14.5%), which is the primary limitation of these studies. It can only be speculated that perhaps dietitians were saturated with surveys, particularly those related to eHealth, for the reason the response rate decreased from the first survey to the second. Whilst a response rate of 60% is the ideal goal,[266-268] these response rates are typical for online surveys[269, 270] and may not reflect lower quality responses.[270] There is potential for participant responses to be biased towards those with an interest in nutrition informatics, however, 54% in 2013 and 45% in 2016 were not familiar with the term nutrition informatics suggesting perhaps that a reasonable sample mix was achieved. The survey relies on self-reported use and experience of eHealth, providing a relative indicator of actual use and experience. This limitation is acknowledged, however minimised by the repeated cross-sectional analysis, which is reporting on change and progress, not just current status.

5.4.3 Summary

As eHealth and consumer demand increases, so will the requirements for dietitians to be involved in eHealth projects.[259] .[259] Large scale EHR implementations have failed from a 'top-down' approach, highlighting the importance of user engagement, to ensure the long-term success of eHealth solutions.[271] Whilst user engagement and acceptance and adoption of technology is necessary for its success, equally important is the implementation of the right solution that integrate the standards and processes of the healthcare professional to support practice requirements and interoperability, as well as leadership to determine the right solution and guide the implementation. Valuable opportunities to enhance nutrition services and achieve the benefits that eHealth can deliver may be missed if dietitians (as the nutrition experts) do not take

the lead in guiding the development, selection and implementation of suitable technologies for the management of patient nutritional care.

The importance of preparing the profession for the future of eHealth was also highlighted by Hickson et al (2017) who identified 'embracing advances in science and technology as one of the five themes to inform the development of a workforce strategy for 2020-2030 for dietetics.'[272] Their recommendation specifically related to technology to prepare the profession for the future, was: 'Consider how to support dietitians to keep pace with technological advances and how to facilitate the uptake of new technology, including expanding the evidence base. It will be important to use technology to its maximum to educate, consult and inform, as well as share the dietetic identity with public.'[272]

In order to improve the gaps in eHealth readiness and overcome the reported barriers, training and educational programs will be instrumental, ensuring dietitians across all age groups and practice areas are equipped with the fundamental technology, information management and advocacy skills to be proactive and pursue involvement in nutrition-related HIT developments and implementations.[259, 273] Continued efforts to increase the awareness of nutrition informatics and the benefits amongst dietitians are also crucial, particularly at the patient and organisational level as this was not realised by the majority of respondents. Dietitian participation to ensure technology solutions reflect the standards and processes required by dietetic practice will be essential to achieving the benefits that eHealth can deliver.[147]

This study was limited due to the adoption of the Academy survey, which wasn't designed around the FeRD, and not thoroughly tested on the Australian dietetic population. The implementation and analysis of this survey identified the use of a variety of eHealth terms (nutrition informatics, HIT, IT and data for example) which could have impacted on the respondents understanding of the questions and led to some misinterpretation of what was being asked. The wording of some questions also need to be fine-tuned to ensure they are gathering exactly what's required for a proper FeRD analysis. Consequently, future versions of this survey will review all the questions, identify the key term/s to be used throughout the survey, and clearly

define them at the beginning for the respondents. In addition, future survey responses related to ‘use of HIT’, will be incorporated into the analysis of Attitudinal or Aptitudinal readiness.

Research to contribute to the evidence of nutrition informatics benefits for patient nutrition care, and the development of best practice criteria for nutrition HIT selection and use will be an important focus for the coming years.[39, 147] However, what this analysis has also identified is the need to improve in the area of advocacy, which will require a collaborative approach from the dietetics profession, utilising the skills and expertise across the practice areas, embracing those with experience, and drawing on the varying expertise (particularly of aptitude and advocacy) demonstrated by the different generations. However, further investigation into understanding the results of the surveys and exploring how to target the specific areas for improvement is essential to strengthen dietitian eHealth readiness (Chapter 6).

CHAPTER 6: NUTRITION INFORMATICS EXPERT INTERVIEWS

* The majority of Chapter 6 has been submitted for peer review:
Maunder K, Williams P, Walton K, Ferguson M & Beck E. (2017). Dietitians will 'miss the boat' for eHealth without strategic leadership: A qualitative study exploring dietitian perspectives of eHealth readiness, *Nutrition and Dietetics*, 'revisions submitted'.

"If we don't change the direction we are headed, we will end up where we are going."

Chinese proverb

6.1 Introduction

The limited awareness of the broader benefits of eHealth, minimal experience with nutrition-related eHealth implementations, and low levels of involvement in eHealth initiatives by dietitians identified in the eHealth readiness study (Chapter 5) is of significant concern and needs to be addressed soon, as the integration of eHealth will inevitably impact dietetic practice. However, the level and quality of dietitian engagement will significantly impact the outcomes for both dietitians and their patients/stakeholders. The development of HIT systems which do not support nutrition standards and processes to maximise efficiencies and assist in delivery of nutrition care, will miss realising the benefits, and could adversely affect quality of care, including safety.[31-33]

Forming the final research chapter in this PhD thesis, this study aimed to provide insight and strategies to assist the profession at a national (and potentially global) level to address this identified and significant gap in dietitian eHealth readiness. The results of these interviews will build on the information obtained from the national nutrition informatics survey which identified Australian dietitians are capable and interested but not yet engaged in HIT implementations (Chapter 5). The research outcomes and recommendations may also have relevance to other allied health professionals.

6.1.1 Aim

The aims of this study were:

- *To identify the perceived barriers and enablers to dietitian eHealth readiness. (Objective 4)*
- *To identify strategies to strengthen the capacity of dietitians to engage in eHealth initiatives and effectively drive successful nutrition-related eHealth implementations. (Objective 5)*

6.2 Methods

This study was conducted between June 2016 and March 2017, encompassing in-depth semi-structured interviews with nutrition informatics experts in Australia to gain insight into their perceptions regarding the lack of dietitian engagement identified in the national eHealth readiness surveys, and to generate rich discussion to address the research study aims. A purposive and 'snowballing' sampling technique was used to select participants with expertise in the field of nutrition informatics and to ensure representation across a variety of practice areas.[179] The selection of dietitian nutrition informatics expert participants was based on meeting at least one of four main criteria: 1. experience with an eHealth implementation; 2. research and publication on eHealth solutions for dietitians; 3. role at a national level as an advocate for eHealth for dietitians; or 4. holding the credential of CHIA. Ethics approval was granted (HE16/202) by the University of Wollongong Human Research Ethics Committee.

The interview guide was developed based on the results of the national eHealth readiness surveys[259, 274] so as to elicit a deeper understanding of dietitian perceptions on the barriers and enablers to greater involvement in eHealth initiatives. The questions were piloted with two dietitians, with some minor modifications made to reduce duplication in responses. The participants were asked ten planned questions, with additional questions only asked when clarification of an answer was required. The questions related to the nutrition informatics expert's perceptions on the benefits of eHealth; risks of not being involved; dietitian eHealth readiness; reasons for lack of dietetic engagement in eHealth projects; the impact dietitian involvement has on eHealth projects; and ways dietitian engagement could be improved (Appendix K).

The digitally recorded interviews were conducted by the primary researcher, face-to-face or over the phone with participants. The interviews were transcribed verbatim by the same researcher.

The data analysis was conducted using QSR NVivo 11 Pro (v11.0.0.317) qualitative analysis software. The transcripts were read and re-read to gain a comprehensive overview of all of the opinions and perceptions expressed by the participants. Thematic analysis[235] was conducted and two researchers (the candidate and one supervisor) independently reviewed each line of data to identify key words and phrases to describe the opinions of participants. The text was labelled as an open code and then once the transcript was coded, all codes were grouped into categories of similar concepts. The codes and concepts were then discussed by the researchers until agreement was reached on the topics and key themes emerging from the data, and data saturation confirmed. The data coding was reviewed with the agreed themes and a selection of exemplar quotes identified to illustrate these themes and topics.[180]

6.3 Results

Ten dietitians who met the criteria of a nutrition informatics expert participated in this study. Practice areas represented included: hospital (management, clinical and foodservices) (n=5), university or research (n=2), Department of Health (n=1), private practice (n=1) and private industry (n=1). Females represented 80% (n=8) of the respondents and was reflective of the profession.[90] The interviews lasted up to fifty minutes, with eight face-to-face and two telephone interviews. Data saturation was reached after eight interviews as shown in Figure 6.1.

The data analysis generated 25 topics which formed four key themes: benefits of eHealth for dietitians; risks of dietitians not being involved in eHealth; dietitians are not ready for eHealth; and improving eHealth readiness strategies (Table 6.1). Exemplar quotes were identified for each of the topics (Table 6.1).

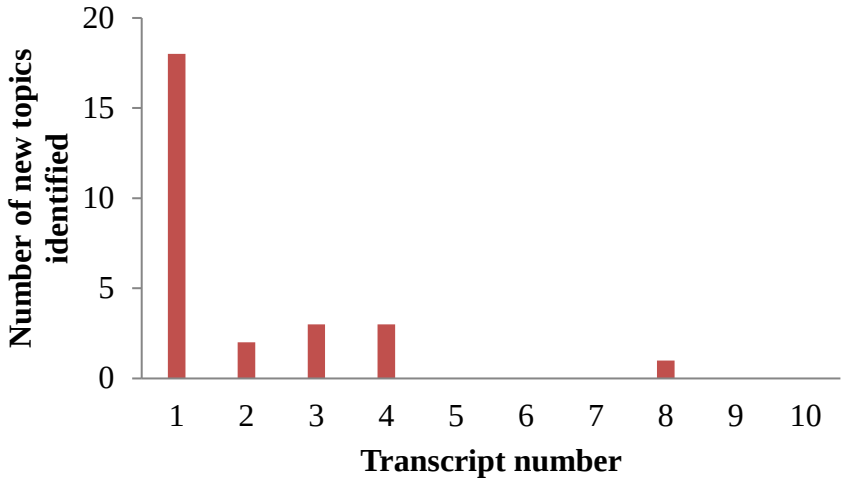


Figure 6.1: Number of new topics emerging in each interview transcript.

Table 6.1: Key themes, topics and exemplar quotes for the interview transcripts.

Themes	Topics	Quotes
1. Benefits of eHealth to dietitians	Access to information	*'So eHealth makes it easy to access information that is going to help you inform your care plan. The benefit of that is you have more co-ordinated integrated care for the patient which would drive better patient outcomes.'* (Interview 6)
	Accuracy and safety	*'I think there is a lot of potential for safety built into it in a much more effective way than what happens in a paper record for example.'* (Interview 3)
	Consumer access to healthcare	*'Keeping up-to-date with what consumers are accessing and what patients (our consumers) are accessing, and providing services to patients in different forms other than traditional face-to-face form to enable a broader reach and I guess meeting patients and consumer needs and ultimately satisfaction.'* (Interview 4)
	Data analytics	*'It can help us target our service because it can provide information that will change your service delivery as a result of analysing larger pieces of data.'* (Interview 1)
	Efficiency	*'The immediacy of access, so not just the waiting time, but no matter where you are you can find them, access them, many people can be using it at the same time.'* (Interview 3)

Themes	Topics	Quotes
2. Risks of dietitians not being involved in eHealth	Clinical risk	*'I think you can have some clinical risks and you know we've seen that in some of our hospitals.'* (Interview 8)
	Lose professional domain	*'I think dietitians risk being left behind, becoming out of touch, and being seen as redundant. A rise in other nutrition professionals, or professionals claiming to have nutrition qualifications and training, and being better at using certain aspects of eHealth and promoting themselves.'* (Interview 9)
	Miss the benefits	*'Well, as a profession we won't get the benefits, we won't get the initiatives, we won't get innovation. We would possibly be lost and swamped by a multiple other professions who will ultimately leverage off that data and leverage off the opportunities to change and grow and capture that patient interest in the sense of healthcare…'* (Interview 1)
	Systems not suited to profession's requirements	*'I think that's the biggest risk, decisions are going to be made without them, systems are going to be built that don't require a dietitian, and some EMRs [electronic medical records] can be completely setup to not require dietitian involvement.'* (Interview 2)
3. Dietitians are not ready for eHealth	Disconnect between IT and clinical departments	*'So, I think that lack of a link, or lack of communication with IT departments, or lack of connection, has resulted in dietitians being very disengaged from the process.'* (Interview 9)
	Focused on role and not seeing the bigger picture	*'And that may be for any number of reasons, we are all busy people and we are focused on patient care and we don't see the immediate benefit of our time and effort.'* (Interview 6)
	Frustration	*'I feel there is a huge amount of frustration that we were unable to move things forward and have real meaningful headway into getting and attracting interest within the profession, even though as an industry health informatics has not stopped, in fact it has escalated exponentially, but as a profession our interest has not followed that vein.'* (Interview 1)
	Generational	*'The younger generation has grown up with technology; they expect it to be in their daily lives, so when you suggest ideas that involve electronic systems they are much more ready to use that.'* (Interview 2)

Themes	Topics	Quotes
	Lack of enthusiasm or interest	*'I do think that because there is very little current interest in the dietetics field about nutrition informatics or not so much current interest, but certainly a lack of enthusiasm.'* (Interview 1)
	Lack of informatics expertise	*'Part of the frustration is, that once this thing has been designed is that you can't go back and re-design, and there are all sorts of rules and barriers. We've had a very frustrating time going back and asking can we start again, and they say sure you can start again, but they aren't making the changes we put forward.'* (Interview 6)
	Lack of knowledge, awareness and confidence	*'I think the fear, lack of understanding, so there is a lot out there; it's not just one thing.'* (Interview 7)
	Lack of progress	*'I feel we are a pretty passive workforce, that we will adopt technology when it is given to us, or we will critique it when it's handed to us. But on a whole I don't think we are well engaged as a profession in this sort of stuff.'* (Interview 6)
4. Improving eHealth readiness strategies	Collaboration and representation	*'I think that if we got involved in some of those key organisations that are involved in nutrition informatics or health informatics that it puts us on the map, it creates a skill level for us that keeps the conversation going. It probably embeds us as a profession within that whole health network, and if we don't do it we'll miss the opportunity altogether or someone will come in and provide it for us, but it will be with their perspective of dietetics which may not be within our profession.'* (Interview 1)
	Education	*'I think that we need to provide more education about what eHealth is; that it's more than just the EHR [electronic health record], which is how eHealth is widely seen by clinical dietitians in hospitals. We need to provide education about existing systems and how they fit in, how they are existing eHealth systems I guess, and also future possibilities.'* (Interview 9)

Themes	Topics	Quotes
	Offer incentives	*'I do think that because there is very little current interest in the dietetics field about nutrition informatics or not so much not current interest, but certainly a lack of enthusiasm that perhaps we might need some sort of impetus to get us over the hurdle to help bring an awareness or create a profile or create a structure for us as a profession to move forward.'* (Interview 1)
	Mentoring	*'So I suppose it's a matter of supporting, encouraging, mentoring and building confidence from a professional perspective about a field that was not our primary area of study.'* (Interview 1)
	National strategy	*'I think DAA [Dietitians Association of Australia] have a role to play here to actually educate, promote and assist dietitians to become better informed about eHealth, what eHealth is, how it impacts us and what the risks are of not embracing it as a profession.'* (Interview 9)
	Organisational leaders	*'Obviously for individual dietitians it is very difficult for them to change a whole system or whole approach, but those in positions of leadership are the ones who can help guide, help reassure, help put stepping stones in place to have it all happen.'* (Interview 3)
	Nutrition informatics champions	*'I do think you need big picture people, holistic people, visionary people in place to get some of the big overarching stepping stones in place, and we need the right people in the right place at the right time.'* (Interview 3)
	Supportive environment	*'But how do we manage to keep those people together, those people with the view, the vision, the insight and the big picture, how do we connect all of these pieces of a massive spider web together and again I think the professional organisation is one means by which we can do that.'* (Interview 3)

Theme 1: Benefits of eHealth for dietitians

The benefits of eHealth to dietitians were clearly articulated and became an obvious theme of the interviews. The responses identified all of the same topics outlined in the eHealth readiness survey relating to the benefits of eHealth for dietitians, including two benefits (accuracy and safety, and consumer access to healthcare),

which only 38% and 37% respectively of survey participants agreed were benefits of eHealth.[259, 274] One quote encompassed several of the benefits in one response: *"By using the data you can get out of an eHealth system to actually drive decision making processes around models of care. So I would be saying we are collecting a lot of data through eHealth, all sorts of dietitian specific and health specific, you could bring it together to inform how we deploy the workforce, looking for where our best bang for the buck is in terms of patient outcomes, because there is little health dollar…and I think we need to be smart about how and where we deploy staff, and so eHealth is a way that we can start to make those decisions. For example, we did this particular model of care and this was the outcome for the patient"* (Interview 6).

Theme 2: Risks of dietitians not being involved in eHealth

The risks to dietitians not being involved in eHealth extend beyond just missing the benefits. The topics identified during the interviews also outlined the potential for clinical risk, which is a possibility if solutions for dietitians are developed by those without the nutrition expertise. The management of diet restrictions and allergies in hospital patients for example, need to be accurately linked to the corresponding codes in order for hospital interfaces to be safe and reliable.

A similar topic identified was systems not suited to the professions' requirements, meaning if dietitians are not involved in the development of a HIT solution, it may not end up including the key fields and processes required to support dietetic practice, and consequently will not be adopted by dietitians. The ultimate risk, however, is dietitians "*will become obsolete*" (Interview 5), with others claiming authority in the nutrition space.

Theme 3: Dietitians are not ready for eHealth

Dietitians are not ready for eHealth was a clear theme arising from the interviews with eight topics revealed contributing to this belief. The topics identify barriers to dietitian eHealth readiness, including dietitians' lack of knowledge, awareness, confidence and informatics expertise in relation to eHealth that was most often discussed. It was identified that eHealth projects are often challenging and difficult to engage in, with the terminology and processes foreign to a dietitian, so they are

"*getting dragged along with what the organisation is doing*" (Interview 4) due to their lack of informatics expertise, rather than confidently driving clear nutrition-related solutions. In addition, the importance of a fine balance was highlighted, "*balance between collecting data for research purposes and having a system that promotes good workflow and good communication… because it's very easy to create for example a progress note that is a blank page and that's the electronic equivalent to the patient paper note, but that doesn't give you any of the added benefit that eHealth provides*" (Interview 6). This quote provides a clear example supporting the need for someone with informatics skills and experience.

There was frustration with the current lack of progress across the profession, passive engagement, and lack of national support and strategy for moving the profession forward. A quote from one of the participants: *"We need to move forward as a group and we need to move forward with I guess a united idea of what this concept is and clearly that's not happening*" (Interview 7).

Theme 4: Improving eHealth readiness strategies

Eight strategies were identified which will enable eHealth readiness: collaboration, incentives, education, mentoring, national strategy, leaders, champions, and supportive environment. Many of these strategies were related to leadership: collaboration and representation; organisational leaders and nutrition informatics champions. Collaboration and representation recommendations were reported on a multitude of levels, starting from individual organisations, to state-wide, to national and international opportunities, whereas the other two topics related more to individual leadership attributes.

For the strategy of organisational leadership, it was suggested that this could be fulfilled by those already in a position of leadership, or alternatively it may require a dedicated position. "*It may need a dedicated project type role, where it would be a key strategy of the organisation to further develop and once that interest is created I suspect a higher uptake of interested parties can then have a snowball effect and move the profession forward*" (Interview 1).

Supporting the suggestion of nutrition informatics champions were the following quotes: "*Have some sort of group or a group that can show leadership and start to drive the process and upskill people and start to really inspire people who don't necessarily don't want to lead, but who are interested in the area and that tiny bit of interest is all we need to start the ball rolling and get others on board*" (Interview 7). "*I do think champions are helpful, the thing I think are helpful about champions is almost a pure sales approach if I can say, so the champions themselves have been upskilled, but after a couple of years need a rest, but I think they can be a buddy or guide to the next generation of champions. So if any one of them could then be a support for several other newer people coming on board, then 10 becomes 100 becomes 1000 in no time at all if we use that type of approach. I think that supportive model could be very strong and very valuable*" (Interview 3).

Education and mentoring were highlighted in regard to creating opportunities for eHealth awareness raising and exposure. The need for a national strategy with "*simple messages, and consistent hammering of those key areas"* (Interview 5) to members, and an action plan to "*influence at a national commonwealth level*" (Interview 5) eHealth standards and policies. Also raised was the need to create an '*impetus to get over the hurdle for the profession to move forward*' (Interview 1), and an '*incentive*' (Interview 8) for individuals to get involved. A supportive or enabling environment to enable the co-ordination of the effort required for the profession in this space, '*with everyone working together to achieve these goals*' (Interview 3).

Whilst the participants suggested many strategies for improving eHealth readiness, when prompted they found it difficult to identify who, and how these strategies could be co-ordinated and actioned. Primarily the Dietitians Association of Australia (DAA) and universities were identified as having key roles in assisting with providing education to increase awareness of eHealth, to provide incentives, develop a national strategy, and to provide a supportive environment. To quote: "*I think that Universities certainly have a role for the future graduates – talk about eHealth, what it is, how it fits in, and it's more than just EMR or nutrition support software that you might use in your workplace. I think DAA have a role to play here to actually educate, promote and assist dietitians to become better informed about eHealth,*

what eHealth is, how it impacts us and what the risks are of not embracing it as a profession" (Interview 9).

6.4 Discussion

Following on from the quantitative method employed by the national eHealth readiness study of Australian dietitians,[259, 274] this research study adopted a qualitative method, using in-depth interviews to explore eHealth readiness and the issues relating to why dietitians are not yet becoming engaged in eHealth initiatives. The interviews rapidly identified similar topics forming four key themes, with similar responses and perspectives being reported by all the nutrition informatics expert participants. There was agreement that there were benefits to dietitians in using eHealth, as well as risks of dietitians not being involved. However, there was frustration with the current lack of progress across the profession, and overwhelming consensus that dietitians were not yet ready for eHealth. This supports the findings of the eHealth readiness study.[259, 274] Eight key strategies on how to improve dietitian readiness for eHealth were also identified.

The benefits identified during the interviews were comprehensive and reflect commonly reported key eHealth benefits, all of which contribute to the ultimate goal of eHealth: to improve the quality of healthcare delivery.[44-46] The achievement of this goal in dietetics has demonstrated improvements in the consolidation and reconciliation of patient information (including the incorporation of data standards),[141, 275, 276] accuracy and safety;[24] efficiencies;[141, 276, 277] and patient nutrition outcomes.[275, 278] Nutrition focused studies have also demonstrated efficiencies gained through eHealth which can contribute to cost savings,[141, 275] or allow for increased time to be devoted to direct patient care and enhancing the care experience for patients and healthcare providers.[279] The electronic medium also enables easy and convenient access to valuable standardised or structured clinical data on a large scale. This data supports research into health outcomes which can contribute to better patient care, support clinical decision-making and improve patient outcomes.[44,45] From the results of a SLR of nutrition informatics in clinical practice, North et al (2015) concluded nutrition informatics presents an opportunity to improve the quality and efficiency of patient care by dietitians.[50]

The risks of dietitians not being involved in eHealth became the second theme, which like benefits, are an important part of this discussion.[68] Whilst the benefits can form positive messages to promote the importance of eHealth readiness to the profession, presenting the risks has the potential to create a strong incentive to the profession to become more aware and involved. It was reported that dietitians will miss out on the benefits eHealth offers, potentially introducing or fostering clinical risk, and becoming irrelevant; even losing their professional domain. This is an issue in social media which has recently been flagged anecdotally as a significant risk to the profession; the uprising of the non-nutrition professionals providing nutrition information and advice to the general public. As a result, the DAA, as well as other dietetic professional groups and individuals, have actively campaigned to promote the role of the professional nutrition expert throughout social media.

There were strong opinions relating to the theme that dietitians are not ready for eHealth, and several potential barriers for this identified. These reasons should be taken into consideration and targeted when developing the strategies to address dietitian eHealth readiness. For example, how can we leverage the younger generations' knowledge and confidence with technology to improve the professions interest and enthusiasm for eHealth? Dietitians are not aware of the benefits of these solutions, the risks of not being involved, and consequently are not confident to lead opportunities related to nutrition HIT initiatives.

The fourth and final theme encompassed the strategies or enablers for improving eHealth readiness amongst the profession. This area is challenging, with no previous framework to guide the profession and insufficient investment in reflecting on our limited experiences, to identify how we can do better moving forward. The need for strong and active leadership is clearly an essential ingredient for eHealth advancement and one key area where the profession is lagging, and several ideas on the types of leadership required were discussed. A SLR by Ingebrigtsen et al (2014) revealed a moderate level of evidence that clinical leaders who have technical skills and experience with eHealth project management are instrumental in the successful adoption of eHealth.[43] The attributes of these clinical leaders suggest they are likely to develop a long-term vision, motivate and foster the necessary IT competencies,

establish partnerships with IT representatives, can maintain confidence and stability through the adversities that these projects often entail, and are consequently associated with successful organisational and clinical outcomes through eHealth initiatives.[43]

The importance of greater collaboration and engagement by dietitians as part of the development and implementation process of eHealth solutions has also been identified in research studies, and in particular in several with nutrition focus.[50, 280, 281] Chen et al's (2017) research on designing mHealth apps to support dietetic practice, concluded that it was critical for dietitians and the app developer to collaborate in order to achieve dietitian and patient-centred app designs.[281] During the development of an eHealth solution for dietitians, Mirtallo et al (2009) report that dietitians were consulted, and ultimately ensured optimised nutrition care functionality.[280]

However, strategies to enhance leadership and engagement, and to prepare dietitians for eHealth readiness would usually require resources, and ideally should be co-ordinated across the entire profession. Here lies the challenge, as dietetics is a small profession with limited paid and voluntary resources, and with the practice area of nutrition informatics estimated to comprise less than one percent of the dietetic workforce. The exact numbers involved primarily in informatics is not clear, as it is not one of the DAA defined practice areas listed in annual reporting. However, the national eHealth readiness surveys reported one per cent.[259, 274] It is critical to recognise that while the number of informatics specialists in dietetics is small (and may remain so), the use of eHealth crosses all practice areas, and will ultimately affect all dietitians and their nutrition care practice. The DAA Nutrition Informatics Interest Group has been providing CPD opportunities since its formation in 2013. However, the reach is limited, with the members being dietitians with an existing interest and awareness of eHealth.

Some topics related to strategies that did not arise in the interviews included competency standards for dietitians and health (or specifically nutrition) informatics certifications. Ayres et al (2012) from the Academy identified that whilst other

professions had addressed informatics competencies at different levels of practice, the dietetics profession had not.[273] The Academy defined informatics competencies of dietitians, and determined the assignment of each competency to the appropriate level of practice (based on the six levels of practice from the Academy's Career Development Guide). [273] In addition, within the topic of 'collaboration and representation', no key eHealth organisations, committees or projects were mentioned, such as HL7, FHIR HIMSS or the Agency. Similarly, none of the interviewees identified the importance of ensuring dietitian involvement in national eHealth policy and standards; ensuring nutrition is incorporated as part of regulation and policy and to ensure interoperability. Another possible strategy that was not identified during the interviews is the support and encouragement of research contributing to the evidence of nutrition informatics benefits for patient nutrition care, as well as the development of best practice criteria for nutrition HIT selection and use as a potential important focus for the coming years.[39, 147]

As with any interviews, a limitation is the risk that participants may not reveal all of their true opinions as they may wish to please the interviewer. This method was specifically chosen over focus groups for example, as there is the risk that the responses may be influenced by a dominant view, and alternate views may be less accepted or possibly not externalised.[223] In addition, the participants represented experienced practitioners and experts in this field, so were more likely to feel confident and comfortable with their opinions and responses than the general dietetics population.

Dietitians need to demonstrate they are the clinical leaders for nutrition, and ensure they are driving the eHealth solutions for nutrition care, not financiers or technologists. To achieve this, it is critical that dietitians are equipped with the knowledge, skills, confidence, informatics expertise, and leadership capacity to become key stakeholders in HIT development, selection and implementation of credible solutions, and make informed decisions about how to utilise, lead and drive eHealth initiatives to enhance practice. If dietitians do not embrace this opportunity, others may take their place, or dietitians may be forced to use eHealth in ways that are not the most effective for practice or maximising patient outcomes. However,

achieving this is complex, and to quote one of the interviewed nutrition informatics experts, if we continue to be complacent and not actively enhance our eHealth readiness, we "*will definitely miss the boat*" for eHealth.

Being aboard the 'boat' will require collaboration across the profession, including developing a national advocacy and strategic plan; enhancing university training and graduate competency; engaging and collaborating with external organisations to ensure inclusion and interoperability (incorporated into standards and policy); utilising the skills and expertise across the practice areas to identify champions and leaders; embracing those with experience; and drawing on the varying expertise demonstrated by the different generations.

CHAPTER 7: CONCLUSION AND FUTURE DIRECTIONS

"If we continue to develop our technology without wisdom or prudence, our servant may prove to be our executioner."

Omar Bradley (1893 –1981)

General, US Army (Armistice Day speech (11 November 1948))

7.1 Summary of this research

The primary aim of this research was to examine the benefits of nutrition informatics in hospital foodservices, and to critically evaluate the readiness of dietitians for eHealth – to determine '*are dietitians ripe for disruption?*' This research was important due to the emergence of eHealth within nutrition practice areas, a paucity of literature on the benefits of nutrition informatics, the absence of a framework or tool for assessing dietitian eHealth readiness, and minimal knowledge on dietitian eHealth readiness. Therefore, this research is both timely and warranted, aiming to highlight the importance of eHealth readiness for dietitians, and encourage the development of strategies and solutions to better prepare them to practice in the digital age and achieve the potential benefits for patient nutrition care.

The hypothesis examined in this thesis was that nutrition informatics could provide valuable benefits for dietitians, however the dietetics profession is not yet sufficiently ready for eHealth opportunities. In order to examine this topic, five research questions were developed and addressed across three phases and six studies using a multi-method approachs. The results of this thesis have demonstrated some of the potential benefits of nutrition informatics, and supported the hypothesis that whilst dietitians in Australia may believe they are ready for eHealth, there are a number of indicators to the contrary. There are significant risks associated with not being ready, and there are specific areas that should be targeted for improvement (based on the FeRD). To summarise the outcomes, the findings of each study are briefly described below as they relate to the research objectives.

7.1.1 Significant benefits of nutrition informatics in hospitals

Two studies were conducted to address research *Objective 1: To demonstrate the potential benefits of nutrition informatics in hospitals, by replacing a patient paper menu system with a BMOS in the hospital environment.* Both studies demonstrated comparable findings, including significant improvements in dietary intake, which is associated with improved patient outcomes and LOS.[228-230] Patient and staff satisfaction were also noted to increase with the implementation of the BMOS. With the evidence that nutrition informatics is beneficial in at least one dietetic practice area, and the knowledge that readiness for eHealth has demonstrated to reduce the risk of failure,[82-84] further research investment in determining the dietitian readiness for eHealth was warranted.

7.1.2 Framework for assessing the eHealth readiness of dietitians (FeRD)

To determine the eHealth readiness of dietitians, a framework or tool to guide this investigation was required. Studies 2a and 2b were designed to address research *Objective 2*: *To develop and validate a framework to assess the eHealth readiness of dietitians.* A SLR (study 2a) found no existing framework or tool for guiding the assessment of the eHealth readiness of any allied health professional. However, there was sufficient literature on eHealth readiness to identify relevant themes that could be used to develop a framework. Study 2b engaged nutrition informatics experts in semi-structured interviews to validate the framework.

The result was a framework for assessing the eHealth readiness of dietitians (FeRD), incorporating five dimensions:

Access:	Access to the required information technology infrastructure (including software/apps, hardware and networks) and funding.
Standards:	Documented terminology and process standards.
Attitude:	Knowledge of eHealth (what it is and the benefits); awareness of the need to change; and willingness to utilise eHealth solutions.
Aptitude:	Ability to utilise eHealth solutions.
Advocacy:	Capacity to lead and support eHealth initiatives; engage stakeholders; and communicate requirements.

The FeRD is an innovation that builds on existing theories and frameworks of eHealth readiness and incorporates expert opinions, providing a comprehensive platform for the analysis and identification of areas for professional improvement to enable the benefits of eHealth to be realised. The FeRD was utilised to guide the national dietitian eHealth readiness assessment for the following research phase.

7.1.3 Dietitian eHealth readiness

Two national surveys were conducted to form an eHealth readiness study (3a) to address research *Objective 3: To determine the eHealth readiness, and changes over time, of Australian dietitians*; and *Objective 4: To identify the perceived barriers and enablers to dietitian eHealth readiness.* The FeRD was utilised to analyse the responses, providing a comprehensive picture of dietitian readiness within each dimension and how that may be changing over time.

Overall, the key dimensions (and key areas) identified for improvement were:

Attitude: Limited knowledge of the broader benefits of eHealth, such as improving patient safety and quality of care and reducing medical errors.

Aptitude: Minimal experience with eHealth initiatives.

Advocacy: Low levels involvement with eHealth initiatives.

Utilising the FeRD to analyse the responses provided baseline data and an indicative trend of dietitian eHealth readiness, demonstrating a moderate level of eHealth readiness by Australian dietitians, however with limited progress over the three years.. The barriers remained consistent over time, with the top three issues (related to employer, technology and training) being reported by 26-30% of respondents. Valuable opportunities to enhance nutrition services and achieve the benefits that eHealth can deliver may be missed if dietitians do not take the lead in guiding the development, selection and implementation of suitable technologies for the management of patient nutritional care. With this understanding, further investigation was needed into understanding of dietitian eHealth readiness, and to identify strategies to strengthen the capacity of dietitians to engage in eHealth initiatives and effectively drive successful nutrition-related eHealth implementations.

7.1.4 Strategies to strengthen the capacity of dietitians to engage in eHealth initiatives

Semi-structured in-depth interviews with nutrition informatics experts (study 3b) were conducted to further address Objective 4: *To identify the perceived barriers and enablers to dietitian eHealth readiness*; and *Objective 5: To identify strategies to strengthen the capacity of dietitians to engage in eHealth initiatives and effectively drive successful nutrition-related eHealth implementations.*

The experts reported a clear belief that using eHealth can benefit dietitians; identified there are risks of dietitians not being involved; and provided further evidence that dietitians are not yet ready for eHealth. The topics identified within the theme of risks extended beyond just missing the benefits, to include the clinical risk, eHealth systems not suited to dietitian requirements, and the concern that dietitians may lose their professional domain. The barriers, reported under the theme 'dietitians are not ready for eHealth', included: the disconnect between IT and clinical departments in the healthcare environment; dietitians are focused on their role and not seeing the bigger picture; lack of enthusiasm or interest in eHealth; lack of informatics expertise; lack of knowledge, awareness and confidence; and lack of progress.

The eight strategies identified for improving eHealth readiness were:

Collaboration and representation
Education
Offer incentives
Mentoring
National strategy
Nutrition informatics champions
Organisational leaders
Supportive environment

Three of the strategies could be related to leadership: collaboration and representation, organisational leaders and nutrition informatics champions. Consequently, any national strategy will need to incorporate all of these strategies, and most importantly strengthen the capacity for leadership within the area of

eHealth, identifying leaders or champions to support the long-term vision. It will be those nutrition informatics leaders who will also motivate and foster the necessary educational competencies, education and mentoring programs; establish partnerships with industry and eHealth organisations; and can build the supportive environment for all dietitians (including organisational leaders).

7.1.5 Strategic recommendations

Under the umbrella of these identified strategies, strategic recommendations for the dietetics profession include:

1. Recruit dietitian eHealth expert champion/s to develop and drive a national strategy. This role could be responsible for co-ordinating the following strategies, as well as investigating the feasibility of a mentoring and incentive program; a nutrition informatics 'champions' process for identifying and upskilling dietitians; developing and providing a supportive environment; onboarding organisational leaders; encouraging and supporting nutrition informatics research; and determining and driving the strategy for education and CPD. As previously discussed, experts in nutrition informatics are limited and not easily identified. Health informatics experience, advanced education and supporting credentials will be a crucial part of this position.

2. Develop Australian key competency standards for University dietitian graduates and for advanced practice in nutrition informatics. This process should include a collaboration with DAA and Australian universities, as well as the Academy and HISA. The Academy have developed specific nutrition informatics competencies;[273] HISA have developed the CHIA program (health informatics competencies) and nursing informatics competencies;[1, 282] and some universities have started incorporating health informatics competencies into healthcare-related degrees.[283] There may be an opportunity to collaborate and identify both graduate requirements, as well as specific nutrition informatics expertise that could be incorporated into all of these programs, and then allow for the identification and recognition of dietitians with these advanced skills and experience.

3. Collaborate and ensure representation on organisations, committees and institutions (including the Academy HL7 nutrition on FHIR or HL7 orders and observations project committees, Agency and HIMSS). In addition, ensure involvement in the development and review of national eHealth policy and standards, advocating for nutrition to be incorporated as part of regulation and policy, and to ensure interoperability. This requires consistent, co-ordinated and active participation.

4. Develop best practice criteria for the selection and use of nutrition eHealth solutions. Given the lack of eHealth readiness, comes a lack of understanding of what's required of eHealth solutions. Equipping dietitians with the knowledge to know what to look for and how to create detailed requirements specifications for potential eHealth solutions will be important.

5. Create a policy for the utilisation of demonstrated beneficial eHealth solutions that bring improved efficiency, safety and patient benefits (example: hospital BMOS), such as being done for the EHR. Given our slow adoption of eHealth to-date suggest incentives may be required to engage dietitians and ensure they are pursuing innovative eHealth solutions to support their practice and the needs of their clients.

These strategic recommendations build on some of the recommendations to the DAA board from HIAC,[156] and are well supported by other health informatics initiatives, such as in nursing and by US dietitians. One decade ago (2007), Charney (US dietitian) wrote 'it is no longer acceptable for healthcare professionals to have only a basic understanding of technology tools,' and emphasised the need for dietitians with advanced technology skills to ensure the work of dietitians is incorporated into future eHealth solutions.[284] Since then, there has been a strong focus on nutrition informatics by the Academy, supported by a team of Academy staff and member volunteers. Strategies two and three are well developed by the Academy, with competencies developed to recognise the various levels of expertise (novice, competent, proficient, informatics specialist, informatics expert).[14, 273]
These strategic recommendations will require resources, which to-date the Australian profession has been unable to support. This has been demonstrated through the loss

of HIAC as the overarching group and central contact for health informatics within the profession; the possible loss of the nutrition informatics Interest Group; as well as the lack of consistent and ongoing representation on health informatics committees and projects.[155, 157] However, these recommendations are aligned with an Australian government priority, as outlined in the recently released Australia's National Digital Health Strategy (August 2017), which may be the impetus to gain the required recognition, support and funding for these strategies. Funding opportunities may be for DAA, or via other organisations, such as the Agency or HISA. Two of the seven Digital Health Strategies specifically relevant to dietitians (and the above recommendations), include: 'digitally-enabled models of care that improve accessibility, quality, safety and efficiency' (fifth) and 'a workforce confidently using digital health technologies to deliver health and care' (sixth).[56]

As part of the fifth Digital Health Strategy, 'better management of chronic disease (including health care homes)' is specified as one of the clinical priorities.[56] The fifth strategic recommendation fits into this priority, with the improvement and co-ordination of patient nutritional care, specifically nutritional intake and the focus on minimising the risk of malnutrition, which is related to longer recovery rates, increased length of stay and higher readmission rates. As part of the sixth Digital Health Strategy, the priorities are very closely linked to the above strategic recommendations (1-4): 'help made available', 'digital health training provided throughout training pathways', digital health integrated into national standards' and 'a network of clinical digital health champions.'[56] This reinforces these strategic recommendations, and in particular the concept of champions, stating 'a network of clinical digital health champions, who understand the benefits of digital health and encourage the upskilling of the workforce across the health system into the future, is important to build momentum and a critical mass of digital health proponents.'[56]

7.1.6 Summary

Whilst the results of the individual studies outlined above addressed the research objectives, when the studies were considered as a whole using the triangulation methodology, a more comprehensive understanding of the barriers to dietitian

eHealth readiness was exposed and the overall hypothesis has been confirmed. A significant finding of this research revealed the complexity of eHealth readiness and identified the lack of understanding of what readiness entails by the profession. This may be the key issue and the first place for the profession to focus eHealth awareness efforts. It appears that understanding of readiness is limited to personal experience (and unfortunately dietetic experience in eHealth is very low), and therefore is often assumed to be made up only of attitude and aptitude. Dietitians' high confidence and experience in using computers, may be creating their belief that they are ready for eHealth, when in fact they are not (when all dimensions of readiness are assessed). It is this belief, and the idea that simply raising awareness will be sufficient to prepare those that are not ready (in terms of attitude and aptitude), that is placing the profession in danger of being complacent and missing the opportunities eHealth will facilitate.

There is an opportunity to embrace this knowledge, and for dietitians to demonstrate they are the clinical leaders for nutrition, and ensure they are driving the eHealth solutions for nutrition care, not financiers or technologists. Collaboration across the profession and the implementation of these strategic recommendations will be imperative to prepare dietitians for eHealth, and to ensure the profession can practice effectively in the digital age, optimise nutrition care and support research for eHealth. The professional implications of dietitians not being prepared for eHealth are that others may take their place, or that dietitians may be forced to use eHealth in ways that are not the most effective for their practice and not focused on patient outcomes. The valuable opportunities to enhance nutrition services and achieve the benefits that eHealth can deliver may be missed if dietitians do not take the lead in guiding the development, selection and implementation of suitable technologies for the management of patient nutritional care.

There is an opportunity to embrace this knowledge, and create a national strategic action plan for preparing the profession comprehensively for its future with eHealth. Aligning the profession's goals with Australia's National Digital Health Strategy, and through collaboration between the DAA, universities, eHealth organisations and individual professionals will be essential to develop national strategies to strengthen

the capacity of dietitians to prepare for the future of eHealth and ensure dietitians become 'ripe for disruption.'

7.2 Limitations and further research

This research had three key limitations:

1. The literature review (in Section 2.4.3) and the research studies (1a and 1b) were focused on the hospital foodservice setting, only one of several dietetic practice areas. Whilst the benefits of nutrition informatics in other dietetic practice areas are possible, and there may be existing literature on this, it was not feasible within the scope of this research to include all dietetic practice areas.

2. The development of the FeRD (study 2a) was based on a SLR, so was not limited to any country or even specific allied health professional. However, the validation study (study 2b) was conducted for the purpose of this PhD with Australian dietitians, and consequently the FeRD applicability is currently limited to that professional group until future research can be conducted.

3. The eHealth readiness survey utilised for the research study 3a was a modified version of the Academy member nutrition informatics survey, to enable a comparison of the countries. Consequently, the ability to modify the survey was limited, and not necessarily designed completely around the FeRD.

Further research could encompass:

1. Further research on the benefits of the BMOS and other eMOS, with a particular focus on nutritional 'at risk' patients, to build and strengthen the evidence base for supporting the management of hospital malnutrition.

2. Research on the benefits of nutrition informatics across other dietetic practice areas, to advance our knowledge, confidence and practice in eHealth.

3. Analyse and redesign the eHealth readiness survey around the FeRD. Then repeat those surveys on an ongoing three yearly basis to monitor the progress of Australian dietitian eHealth readiness, and evaluation of any interventions that have been implemented to improve readiness.

4. Utilise the FeRD to guide a comprehensive analysis and preparation of dietitian readiness on workplace sites prior to an eHealth solution implementation.

5. Conduct focus groups and interviews with other allied health professionals to determine if the FeRD has relevance across all of allied health and is not limited to dietitians.

6. Adapt the eHealth readiness survey for other allied health professionals, in accordance with the FeRD.

7.3 Implications for future practice

Driven by technological advances, government policy and consumer demands, eHealth is already integral in Australian healthcare. Valuable opportunities to enhance nutrition services and achieve the benefits that eHealth has to offer may be missed, risks may be introduced, and the loss of the professional domain are serious possibilities, if dietitians are not appropriately prepared for eHealth.[31, 32] This research has confirmed that for dietitians it should no longer be a question of should they be involved or even how can we raise awareness, but how can dietitians be prepared to be more involved in eHealth to benefit the profession and our clients? It is hoped that the benefits (and risks) to the profession have been clearly articulated, and that it is clear that raising awareness through voluntary CPD avenues is not going to be sufficient preparation for dietitian success in the digital age. The profession needs to understand the complexity of eHealth and eHealth readiness, and develop and deploy national targeted strategic solutions that influence university training/competencies, national and international legislation and policy, enhance collaboration and embrace the existing skills and experience existing within the profession.

Dietitians need to demonstrate they are the clinical leaders for nutrition, and ensure they are driving the eHealth solutions for nutrition care, not financiers or technologists. If dietitians do not embrace this opportunity, others may take their place, or they may be forced to use eHealth in ways that are not the most effective for our practice and focused on patient outcomes. Supported by the National Digital Health Strategy, dietitians should be driving the implementation of eHealth solutions

that have been demonstrated to improve efficiency, safety and patient benefits, such as the hospital BMOS. Transitioning to eHealth solutions as drivers will improve the success of these implementations and better position dietitians with the right solutions to support their practice.

The development of the FeRD has provided the dietetics profession with a valuable tool for assessing the eHealth readiness of dietitians at all levels, from single facilities or areas, to organisations, and even at the state or national level. It also provides a conceptual model to guide the preparation for the implementation of any eHealth solution for dietitians, ensuring all dimensions of readiness are considered before solution deployment. It is hoped that utilisation of this tool and the overall findings of this thesis will be used to ensure dietitians better prepare for the disruption of eHealth, and capitalise on this opportunity to enhance dietetic practice and patient nutritional care.

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APPENDICES

Appendix A – 48-hour Diet Observation Tool

the Mater

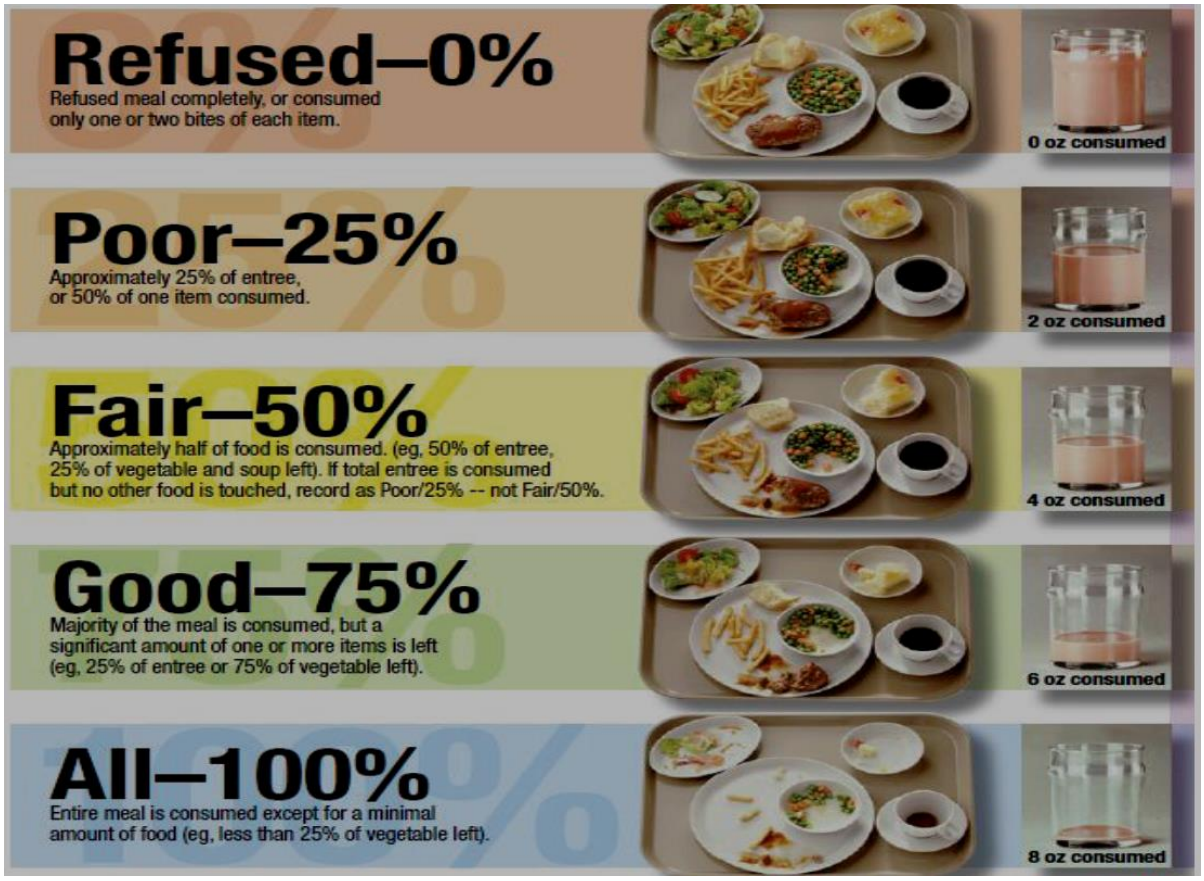
48-HOUR DIET OBSERVATION

(To be completed by Dietitian collecting data)

(Please complete one form for each participating patient)

Meal Type	% food consumed from meal provided					Meal Type	% food consumed from meal provided				
	0	25	50	75	100		0	25	50	75	100
Breakfast						Breakfast					
AM Tea						AM Tea					
Lunch						Lunch					
PM Tea						PM Tea					
Dinner						Dinner					
Supper						Supper					

Day 1 - % Average Intake for 24-hour Period						Day 2 - % Average Intake for 24-hour Period					
%	0	25	50	75	100	%	0	25	50	75	100


Refused–0%
Refused meal completely, or consumed only one or two bites of each item.
0 oz consumed
Poor–25%
Approximately 25% of entree, or 50% of one item consumed.
2 oz consumed
Fair–50%
Approximately half of food is consumed. (eg, 50% of entree, 25% of vegetable and soup left). If total entree is consumed but no other food is touched, record as Poor/25% -- not Fair/50%.
4 oz consumed
Good–75%
Majority of the meal is consumed, but a significant amount of one or more items is left (eg, 25% of entree or 75% of vegetable left).
6 oz consumed
All–100%
Entire meal is consumed except for a minimal amount of food (eg, less than 25% of vegetable left).
8 oz consumed

Appendix B – Foodservice Satisfaction Survey

We are improving the foodservice and we need to know your opinions by completing this questionnaire. Participation in this survey is completely voluntary. Your response will not affect your care in any way and will be confidential. Thank you.

PLEASE MARK YOUR ANSWER WITH A CIRCLE OR A TICK

HUNGER & FOOD QUANTITY						
1. I receive enough food	Always	Often	Sometimes	Rarely	Never	Does not apply
2. I still feel hungry after my meal	Always	Often	Sometimes	Rarely	Never	Does not apply
3. I feel hungry in between meals	Always	Often	Sometimes	Rarely	Never	Does not apply
STAFF/SERVICE ISSUES						
4. I am treated with respect by the staff at mealtimes	Always	Often	Sometimes	Rarely	Never	Does not apply
5. The staff who serve my meals are friendly and polite	Always	Often	Sometimes	Rarely	Never	Does not apply
AUTONOMY						
6. I am asked about my food and drink preferences	Always	Often	Sometimes	Rarely	Never	Does not apply
7. I am able to choose where I sit to eat my meal	Always	Often	Sometimes	Rarely	Never	Does not apply
8. I am able to make suggestions for the menu	Always	Often	Sometimes	Rarely	Never	Does not apply
MEAL QUALITY & ENJOYMENT						
9. The meals taste nice	Always	Often	Sometimes	Rarely	Never	Does not apply
10. The meals have excellent and distinct flavours	Always	Often	Sometimes	Rarely	Never	Does not apply
11. I like the way the vegetables are cooked	Always	Often	Sometimes	Rarely	Never	Does not apply
12. There is enough variety for me to choose meals that I want to eat	Always	Often	Sometimes	Rarely	Never	Does not apply
13. The meat is tough and dry	Always	Often	Sometimes	Rarely	Never	Does not apply
14. The food has been as good as I expected	Always	Often	Sometimes	Rarely	Never	Does not apply
15. I really enjoy eating my meals	Always	Often	Sometimes	Rarely	Never	Does not apply
16. My meals help me to feel good	Always	Often	Sometimes	Rarely	Never	Does not apply
17. I like the amount of food choice I have	Always	Often	Sometimes	Rarely	Never	Does not apply
18. I like the way my meals are presented	Always	Often	Sometimes	Rarely	Never	Does not apply
ADDITIONAL ITEMS						
19.The dining room has a nice social atmosphere at meal times	Always	Often	Sometimes	Rarely	Never	Does not apply
20. The vegetables are too crisp	Always	Often	Sometimes	Rarely	Never	Does not apply
21. The vegetables are too soft	Always	Often	Sometimes	Rarely	Never	Does not apply
22. The hot foods are just the right temperature	Always	Often	Sometimes	Rarely	Never	Does not apply
23. I can suggest the timing of my meals	Always	Often	Sometimes	Rarely	Never	Does not apply
24. I am able to choose the size of my meal	Always	Often	Sometimes	Rarely	Never	Does not apply
25. Chewing food is difficult for me	Always	Often	Sometimes	Rarely	Never	Does not apply
26. Swallowing food is difficult for me	Always	Often	Sometimes	Rarely	Never	Does not apply

PLEASE TURN OVER

27. I am disturbed by noise in the dining area	Always	Often	Sometimes	Rarely	Never	Does not apply
28. The crockery and cutlery are chipped and/or stained	Always	Often	Sometimes	Rarely	Never	Does not apply
29. The staff who serve my meals are neat and clean	Always	Often	Sometimes	Rarely	Never	Does not apply
30. I enjoy having company at meal times	Always	Often	Sometimes	Rarely	Never	Does not apply
31. The cutlery and dining aids are adequate	Always	Often	Sometimes	Rarely	Never	Does not apply
32. The knives are blunt	Always	Often	Sometimes	Rarely	Never	Does not apply
33. By the time I receive my meal, I'd prefer a different choice	Always	Often	Sometimes	Rarely	Never	Does not apply
34. The entrée, main and dessert are served at the same time	Always	Often	Sometimes	Rarely	Never	Does not apply
35. I have access to snack (e.g. sandwiches/toast) preparation facilities whenever I choose	Always	Often	Sometimes	Rarely	Never	Does not apply
36. The main meals are served at times suitable for me	Always	Often	Sometimes	Rarely	Never	Does not apply
37. I can season the food to my taste	Always	Often	Sometimes	Rarely	Never	Does not apply
Overall, how would you rate your satisfaction with the foodservice	Very good	Good	Okay	Poor	Very poor	

What time of day is it at the moment? ……..

Please make some general comments or suggestions:

_____

_____

_____

_____

_____

_____

_____

_____

GENERAL INFORMATION

This information will enable us to identify the level of satisfaction of various groups of our clients, which will help us to assure the quality of our foodservice. All information will be treated as **confidential**. All questions are optional. Please do not complete any questions you feel uncomfortable answering.

Your age is: ……

Your gender is: (please tick the appropriate box)

Female ❑ Male ❑

PLEASE TURN OVER

27. I am disturbed by noise in the dining area	Always	Often	Sometimes	Rarely	Never	Does not apply
28. The crockery and cutlery are chipped and/or stained	Always	Often	Sometimes	Rarely	Never	Does not apply
29. The staff who serve my meals are neat and clean	Always	Often	Sometimes	Rarely	Never	Does not apply
30. I enjoy having company at meal times	Always	Often	Sometimes	Rarely	Never	Does not apply
31. The cutlery and dining aids are adequate	Always	Often	Sometimes	Rarely	Never	Does not apply
32. The knives are blunt	Always	Often	Sometimes	Rarely	Never	Does not apply
33. By the time I receive my meal, I'd prefer a different choice	Always	Often	Sometimes	Rarely	Never	Does not apply
34. The entrée, main and dessert are served at the same time	Always	Often	Sometimes	Rarely	Never	Does not apply
35. I have access to snack (e.g. sandwiches/toast) preparation facilities whenever I choose	Always	Often	Sometimes	Rarely	Never	Does not apply
36. The main meals are served at times suitable for me	Always	Often	Sometimes	Rarely	Never	Does not apply
37. I can season the food to my taste	Always	Often	Sometimes	Rarely	Never	Does not apply
Overall, how would you rate your satisfaction with the foodservice	Very good	Good	Okay	Poor	Very poor	

What time of day is it at the moment? .....

Please make some general comments or suggestions:

_____

_____

_____

_____

_____

_____

_____

_____

GENERAL INFORMATION

This information will enable us to identify the level of satisfaction of various groups of our clients, which will help us to assure the quality of our foodservice. All information will be treated as **confidential**. All questions are optional. Please do not complete any questions you feel uncomfortable answering.

Your age is: .....

Your gender is: (please tick the appropriate box)

Female ❑ Male ❑

PLEASE TURN OVER

Your country of birth was: .....

Your *first* language is: (please tick the appropriate box)

English ❑ Other .....

How long have you been in this part of the hospital? .....

When did you choose your meal? (please tick the appropriate box)

Yesterday ❑ Today ❑ Just before I eat ❑

How is your appetite today? (please tick the appropriate box)

About normal ❑ Better than normal ❑ Worse than normal ❑

In general, would you say your health is: (please circle)

Excellent Very good Good Fair Poor

What sort of diet are you on? (Please tick the appropriate box)

Standard/normal	❑
Fat or carbohydrate modified (cardiac or diabetic)	❑
Fibre modified	❑
Energy and protein increased	❑
Reduced/low salt	❑
Fluid restricted	❑
Soft	❑
Pureed or minced	❑
Other special diets	❑
Not sure	❑

Dining location (Please tick the appropriate box)

Own room ❑
Dining room ❑

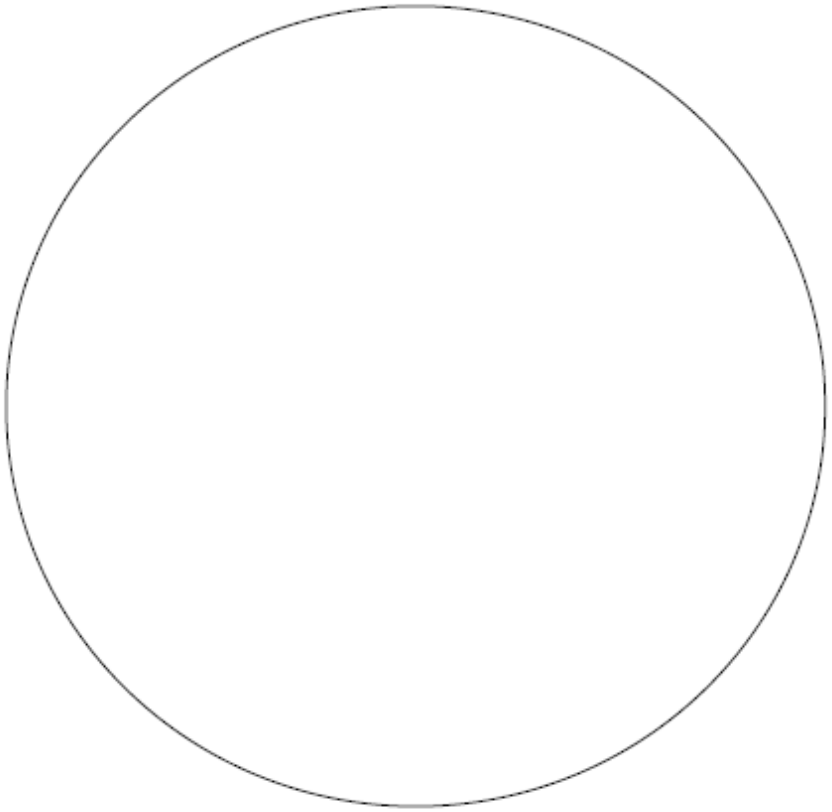
Did you have any assistance with completing this questionnaire? (Please tick the appropriate box)

Yes ❑
No ❑

Reason for assistance: _____

This clock represents the face of a clock with the top of the page representing the top of the clock.

Please put the numbers around the clock and make the clock show the time 10 past 11 o'clock



Thank you

Appendix C – Meal Selections Survey

the Mater

A facility of St Vincents & Mater Health Sydney

Mater Hospital Limited
ABN 36 054 594 375
Rocklands Road
North Sydney NSW 2060
PO Box 958
North Sydney NSW 2059
Australia

T + 61 2 9900 7300
F + 61 2 9959 4110
www.matersydney.com.au

Dear Patient,

A Nutrition Assistant will be visiting you daily to go through your meal selections for Dinner tonight and Breakfast and Lunch for the following day.

We would appreciate if you could provide us with some feedback on our menu service, by completing a short questionnaire.

1. Were you visited by a Nutrition Assistant today? Yes □ No □

2. Were you given adequate selections to choose from? Yes □ No □

3. Have you had any problems with your meal selections? Yes □ No □

If so please state_____

4. Was any advice provided by your Nutrition Assistant with regard to your menu or meal choices? Yes □ No □

If so please state_____

5. Any further comments or suggestions? _____

_____

_____

_____

Appendix D – Nutrition Assistant Satisfaction Survey

NUTRITION ASSISTANT QUESTIONNAIRE

Pre-implementation (Paper Menu Service)

1. Select your age group

   □≤19 □20-29 □30-39 □40+

2. What qualifications have you completed?

_____

_____

3. How long have you worked as a Nutrition Assistant? _____

4. Do you see the same wards each shift? _____

   a. If yes, which wards do you visit?

      _____

5. Do you find staff are aware of your role on the wards?

   □Yes □No □Not Sure

6. Do you find patients are aware of your role on the wards?

   □Yes □No □Not Sure

7. How would you rate the patients response to the menu service?

   □Negatively □Neutral □Positively

8. Do you feel you utilise your nutrition knowledge and skills?

   _____

   a. If so, during what activities?

      _____

9. Do you assist patients with their menu selections?

_____

   a. If so, what types of assistance?

   _____

10. Do you see any opportunities for improvement of the menu service?

_____

   a. If so, please explain.

   _____

   _____

11. Which menu service do you think **you will** prefer?

□Paper Menu □Bedside Menu Service

12. Which menu service do you think **patients will** prefer?

□Paper Menu □Bedside Menu Service

13. How would you rate your work satisfaction with the **paper menu service**?

□Not enjoyable/rewarding □Neutral – don't really mind

□Enjoyable/rewarding □Very enjoyable/rewarding

14. Any further comments or suggestions?

_____

_____

NUTRITION ASSISTANT QUESTIONNAIRE

Post-implementation (Bedside Menu Service)

1. Select your age group

   □≤19 □20-29 □30-39 □40+

2. What qualifications have you completed?

_____

_____

3. How long have you worked as a Nutrition Assistant? _____

4. Do you see the same wards each shift? _____

   a. If yes, which wards do you visit?

      _____

5. Do you find staff are aware of your role on the wards?

   □Yes □No □Not Sure

6. Do you find patients are aware of your role on the wards?

   □Yes □No □Not Sure

7. How would you rate the patients response to the menu service?

   □Negatively □Neutral □Positively

8. Do you feel you utilise your nutrition knowledge and skills?

   _____

   a. If so, during what activities?

      _____

9. Do you assist patients with their menu selections?

   _____

a. If so, what types of assistance?

_____

10. Do you see any opportunities for improvement of the menu service?

_____

_____

a. If so, please explain.

_____

_____

_____

11. Which menu service **do you** prefer?

□Paper Menu □Bedside Menu Service

12. Which menu service do you think **patients** prefer?

□Paper Menu □Bedside Menu Service

13. How would you rate your work satisfaction with the **bedside menu service**?

□Not enjoyable/rewarding □Neutral – don't really mind

□Enjoyable/rewarding □Very enjoyable/rewarding

14. Since using bedside menu service, has your work satisfaction:

□Increased □No change □Decreased

15. Any further comments or suggestions?

_____

_____

Appendix E – Nutrition Assistant Interview Questions

NUTRITION ASSISTANT INTERVIEW QUESTIONS

1. How long have you worked as a Nutrition Assistant?

2. What's the average number of patients you collect selections from? *(NB. Total number of patients will be obtained from ward details to give overall %)*

3. Do you feel the awareness ward staff have of your role on the wards has changed with the commencement of the new bedside menu service?
    a. If so, how? *(ie. Did they know your role existed, or did they think you did something different?)*

4. Do you feel the awareness patients have of your role on the wards has changed with the commencement of the new bedside menu service?
    a. If so, how? *(ie. Did they know your role existed, or did they think you did something different?)*

5. Do you feel patients respond differently to the new menu service (ie. paper menu versus bedside menu)?
    a. Any particular examples or experiences to share?

6. Do you feel you utilise your nutrition knowledge and skills more or less with the new paper menu service?
    a. During what activities?
    b. How often?

7. Do you assist patients with their menu selections more or less with the new paper menu service?
    a. What type of assistance did and do you provide?

8. Do you enjoy your role in taking patient selections more or less with the new paper menu service?
    a. What brings you the most satisfaction in your role?

9. Do you see any opportunities for improvement to the menu service?
    a. If so, please explain.

10. Any further comments or suggestions?

Appendix F – Nutrition Assistant Satisfaction Survey

NUTRITION ASSISTANT QUESTIONNAIRE

Pre-implementation (Paper Menu Service)

1. Select your age group

   □≤19 □20-29 □30-39 □40+

2. What qualifications have you completed?

_____

_____

_____

3. How long have you worked as a Nutrition Assistant? _____

4. Do you see the same wards each shift? _____

   a. If yes, which wards do you visit?

      _____

5. Do you find staff are aware of your role on the wards?

   □Yes □No □Not Sure

6. Do you find patients are aware of your role on the wards?

   □Yes □No □Not Sure

7. How would you rate the patients response to the menu service?

   □Negatively □Neutral □Positively

8. Do you feel you utilise your nutrition knowledge and skills?

   _____

   a. If so, during what activities?

      _____

      _____

9. Do you assist patients with their menu selections?

   _____

   a. If so, what types of assistance?

      _____

10. Do you see any opportunities for improvement of the menu service?

    _____

    a. If so, please explain.

       _____

       _____

11. Which menu service do you think **you will** prefer?

    □Paper Menu □Bedside Menu Service

12. Which menu service do you think **patients will** prefer?

    □Paper Menu □Bedside Menu Service

13. How would you rate your work satisfaction with the **paper menu service**?

    □Not enjoyable/rewarding □Neutral – don't really mind

    □Enjoyable/rewarding □Very enjoyable/rewarding

14. Do you think the new bedside menu service will:

    a. Increase the time you spend with patients? □Yes □No □Not Sure

    b. Improve your work productivity? □Yes □No □Not Sure

    c. Improve your job satisfaction? □Yes □No □Not Sure

15. Any further comments or suggestions?

_____

_____

NUTRITION ASSISTANT QUESTIONNAIRE

Post-implementation (Bedside Menu Service)

1. Select your age group

   □≤19 □20-29 □30-39 □40+

2. What qualifications have you completed?

_____

_____

3. How long have you worked as a Nutrition Assistant? _____

4. Do you see the same wards each shift? _____

   a. If yes, which wards do you visit?

      _____

5. Do you find staff are aware of your role on the wards?

   □Yes □No □Not Sure

6. Do you find patients are aware of your role on the wards?

   □Yes □No □Not Sure

7. How would you rate the patients response to the menu service?

   □Negatively □Neutral □Positively

8. Do you feel you utilise your nutrition knowledge and skills?

   _____

   b. If so, during what activities?

      _____

      _____

9. Do you assist patients with their menu selections?

_____

c. If so, what types of assistance?

_____

_____

10. Do you see any opportunities for improvement of the menu service?

_____

d. If so, please explain.

_____

_____

11. Which menu service **do you** prefer?

□Paper Menu □Bedside Menu Service

12. Which menu service do you think **patients** prefer?

□Paper Menu □Bedside Menu Service

13. How would you rate your work satisfaction with the **bedside menu service**?

□Not enjoyable/rewarding □Neutral – don't really mind

□Enjoyable/rewarding □Very enjoyable/rewarding

14. Since using bedside menu service, has your work satisfaction:

□Increased □No change □Decreased

15. Since using the bedside menu service, has it:

d. Increased the time you spend with patients? □Yes □No □Not Sure

e. Improved your work productivity? □Yes □No □Not Sure

f. Improved your job satisfaction? □Yes □No □Not Sure

16. Any further comments or suggestions?

_____

_____

Appendix G – Nutrition Informatics Expert Framework Validation Interview Questions

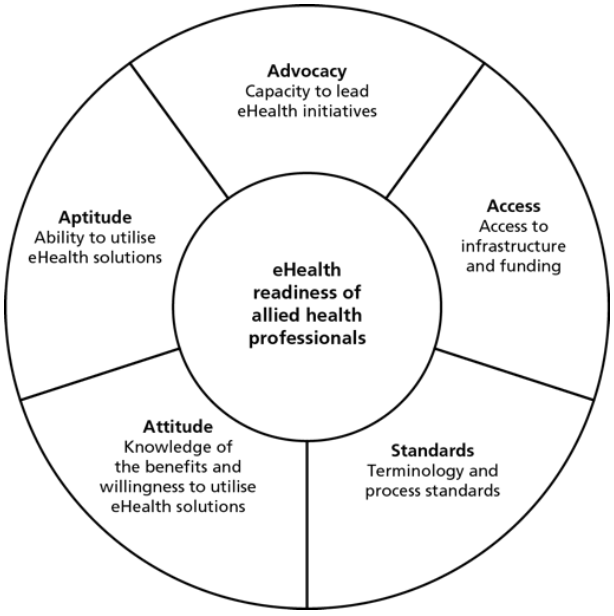
Welcome and overview of what is encompassed by eHealth and the background to this research.

* Note participant current position/dietetic practice area?

1. What attributes would you consider reflects a profession's readiness for eHealth?

* Show the draft framework, and ask:

2. Do you feel this framework covers all of the dimensions of allied health eHealth readiness?
3. Do you feel the dimension names and definitions are suitable?
4. Do you have any other suggestions?



Appendix H – 2013 Australian Dietitian eHealth (Nutrition Informatics) Readiness Survey

Version 1 August 2013

This survey was adapted from the 2011 nutrition informatics survey developed by the Academy of Nutrition and Dietetics Nutrition Informatics Committee and Healthcare Information Management & Systems Society (HIMSS) Analytics.

Contact author: Kirsty Maunder, University of Wollongong, km932@uowmail.edu.au

1. **Which of the below best describes your current primary practice area?** (Please select only one option).

   ☐ Clinical nutrition

   ☐ Community and public health

   ☐ Consultation and business/private practice

   ☐ Education

   ☐ Research

   ☐ Foodservice

   ☐ Food industry

   ☐ Informatics

   ☐ Dietetic student

   ☐ Mixed practice (regularly undertaking 3+ areas of work)

   ☐ Retired (exclude)

   ☐ Do not work in nutrition and/or dietetics

   ☐ Other (Please specify): _____

2. **Please indicate the level of experience you have with retrieving and using electronic data (e.g. using a computer).**
    - 1 – No experience
    - 2
    - 3
    - 4
    - 5 – Highly experienced
    - Don't know

3. **In your primary work setting, do you have <u>access</u> to electronic data (using a computer, mobile computing devices, etc) somewhere at your work place at the time when you need it to do your job?**
    - Yes
    - No
    - Don't know

4. **Do you have <u>access</u> to electronic data (using a computer, mobile computing devices, etc) to support your educational pursuits?**
    - Yes
    - No
    - Don't know

5. **By which mechanism/s do you have <u>access</u> to electronic data at your work place at the time you need it to do your job?** (Please select all that apply).
    - Dedicated computer in my office (e.g. desktop/laptop computer)
    - Mobile computing device (e.g. iPad, smart phone)
    - Shared workstation (e.g. shared department computer, computer at nursing station, workstation on wheels)
    - Smart board (e.g. interactive whiteboard)
    - Other (Please specify): _____

6. **By which mechanism do you have <u>access</u> to electronic data in order to accomplish your educational pursuits?** (Please select all that apply).

- Personally-owned computer (e.g. desktop or laptop)
- University provides me a computer for use
- Shared workstation (e.g. shared department computer computer lab)
- Mobile computing device (e.g. iPad, smart phone)
- Smart board (e.g. interactive whiteboard)
- Other (Please specify): _____

7. **Below are listed a number of areas in which you may require data to support your daily work activities. Through what means have you accessed this type of data in the past six months? For each area, please select all means for which you have accessed data. If you haven't accessed this data in the past six months, please check "not used in the past six months".**

Source of data	Electronically via computer or electronic mobile devices	Paper	Direct interaction (i.e. verbal communication with colleagues, presentations, webinar or pod-cast)	Not used in the past six months	Not applicable in my daily work activities
Billing					
Budget					
Continuing professional education					
Data/information from patients and clients					
Patient data/ information from other professionals					
Diet manual/nutrition care manual					
Drug data/information					
Evidence-based library					
Inventory					
Lay literature					
Nutrient database					
Patient educational materials					
Professional journals					
Project management					
Purchasing					

Recipes/menus					
Sales					
Schedules					
Social Media (i.e. social networking sites, blogs)					
Standards of practice					
Standardised Terminology (i.e. NCPT)					
Textbooks					
Work load statistics					

8. **Please indicate how much you agree or disagree with the following statement: *"I use data and technology available to me to problem solve.*"**
    - 1 – Strongly disagree
    - 2
    - 3
    - 4
    - 5 – Strongly agree
    - Don't know

9. **Please indicate how much you agree or disagree with the following statement: *"I use data and technology available to me for decision making."***
    - 1 – Strongly disagree
    - 2
    - 3
    - 4
    - 5 – Strongly agree
    - Don't know

10. Please indicate which of the following technologies or computer applications you have used in the past six months to support your daily work activities.

Technology or Computer Application	Yes	Not in past six months	Not applicable in my daily work activities
Business management (budget, accounting, billing)			
Clinical nutrition management (patient screening & assessment, nutrient analysis, nutrition care manual, evidence-based practice, nutrition counselling)			
Data analysis (spreadsheets, statistical tools)			
Diet office management (menu correction, patient card files, tray service)			
Electronic health record (an environment including ancillary data, clinical data repository, clinical decision support, nursing, closed loop medication administration, picture archiving and communication system (PACS), computerised provider order entry, physician documentation)			
Personally Controlled Electronic Health Record (an electronic collection of data about an individual's health and health care managed by the individual)			
Foodservice management (recipe production, menu planning, inventory, purchasing, receiving, sales, production)			
Human resources management (schedules, workload statistics, payroll)			
Project management (project implementation schedules, project tracking)			
Web tools for collaboration, communication and education			
Other			

11. Describe your comfort level with using technology or computer applications for each of the items below. (For each item, please select the one best descriptor - beginner, intermediate or expert. If you do not use the technology or computer application, select "no experience".)

Technology or application	**Beginner** I need lots of support	**Intermediate** I can handle most tasks	**Expert** My colleagues come to me for help	**No experience**	**Not applicable in my daily work activities**
Billing applications					
Budget					
Care plans					
Case management					
Graphics					
Inventory					
Menu development					
Menu selection					
Nutrient analysis					
Nutrition assessment					
Nutrition histories					
Nutrition screening					
Patient management					
Creating pod casts					
Project management					
Protocol management					
Purchasing					
Recipe development & management					
Sales applications					
Scheduling					
Slide presentations					
Spreadsheets					
Social media (blogging/social networking sites)					
Statistical analysis					
Web authoring tools					
Web/internet					
Webinars					
Word processing					
Work load statistics					
Other					

12. **What are the reasons/barriers (personal or work related) for not using information technology in your practice or for your education needs?** (Please select all that apply).
    - Training issues (none available, too expensive, no time to train)
    - Employer issues (not required for use, doesn't provide IT, lack of staff to support IT)
    - Technology equipment issues (technology is too costly/complex, too many options available)
    - Personal preference (don't like technology, haven't needed to learn to use IT, benefits not well defined)
    - Access issues (no computer at workplace, workflow is not conducive to use of IT)
    - Don't know
    - Other (Please specify: _____)
    - OR – There are no barriers

13. **In which areas does information technology benefit your work as a dietetics/nutrition professional or student?** (Please select all that apply)
    - Improved access to patient data
    - Improved access to research/education materials
    - Enhanced time management
    - Improved workflow efficiency
    - Performance improvement
    - Reduction/prevention of medical errors
    - Improved patient safety/quality of care
    - Improvements in ability to compile/analyse data
    - Improved communication between care provider/patient
    - Don't know
    - Other (Please specify: _____)
    - OR – There are no benefits

14. **What is your level of involvement at your organisation with each of the below, as part of your daily activities?** (Please select one option for each type of task).

Task	Decision maker	Makes recommendations	No role
Change management			
Hardware selection			
Database management			
Data standards			
Developing terminology			
Interfacing systems			
Mobile computing device/smart phone selection			
Project management			
Social media sites monitoring			
Social media sites managing			
Software selection			
Software implementation			
Software training			
Software support and maintenance			
Software development			
Software enhancement and/or optimisation			
Web-site development			
Web-site management			
Workflow design			
Other			

15. **Would the following help support the use of information technology for your daily activities?** (Please select one answer for each item).

ITEM	Yes	No	Not sure	Not applicable
Provide journal articles on information technology				
Provide professional development session(s) on using technology				
Provide professional development session(s) on nutrition informatics				
Provide reference materials on nutrition informatics				
Provide certification in nutrition informatics				
Provide standards of practice for nutrition informatics				
Electronic health record training/practice application				
Interest Group events and workshops				
Other				

16. **Please indicate the level of integration of your electronic health record (EHR) at your organisation. My work/education setting…** (Please select only one answer).

Definition: *The Electronic Health Record (EHR) is a longitudinal electronic record of patient health data generated by one or more encounters in any care delivery setting. Included in this data are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunisations, laboratory data and radiology reports. The EHR automates and streamlines the clinician's workflow. The EHR has the ability to generate a complete record of a clinical patient encounter - as well as supporting other care-related activities directly or indirectly via interface - including evidence-based decision support, quality management, and outcomes reporting. Healthcare Information Management and Systems Society).*

- Is beginning to think/talk about building an EHR.
- Is soliciting for applications/evaluating vendors.
- Has purchased an EHR but have not implemented.
- Uses an EHR which has nutrition related functions including diet orders and clinical documentation, but does not include the International Dietetics and Nutrition Terminology (IDNT) or Nutrition Care Process (NCP).
- Uses an EHR with structured screens for IDNT or NCP but not both.
- Uses an EHR with structured screens for both NCP and IDNT.
- Uses an EHR, with NCP and IDNT and uses structured data entry for IDNT terminology.
- Isn't a patient care setting that has EHRs.
- Don't know.

17. **Have you heard of nutrition informatics?**

☐ Yes (Please specify where: _____)

☐ No

18. **Have you experienced a nutrition-related IT system implementation in your practice area?**

☐ Yes (Go to Q18a)

☐ No (Go to Q19)

19. If yes, list one system/process and the three main problems that arose, and how were they overcome:

System/Process: _____

1. Problem:_____
   Resolution:
   _____
2. Problem:
   _____
   Resolution:
   _____
3. Problem:
   _____
   Resolution:
   _____

20. If yes, list two project factors implemented well, and the resulting benefits? (Example of factors: project staffing, communication, management involvement, vendor support).

1. Factor:
   _____
   Benefit:
   _____
2. Factor:
   _____
   Benefit:
   _____

21. If you work in a patient care setting, what is the main type of menu used for patients?

☐ Cycle menu

☐ Restaurant style (fixed a la carte menu repeated daily)

☐ Other (Please specify: _____)

☐ Not applicable (not in a patient care setting) (Go to Q20)

22. Do the patients select their own menu choices?

☐ Yes (Go to Q19b)

☐ No (Go to Q20)

23. If yes, what system is used? (Please select all that apply).

- ☐ Paper menu – standard printed menus (manual system)
- ☐ Personalise paper menu – printed from software system (Please specify system:_____)
- ☐ Bedside computer entry by Nutrition/Foodservice staff
- ☐ Bedside computer entry by patient
- ☐ Room Service

DEMOGRAPHICS

24. Select your age category

- Under 25 years
- 25-29
- 30-34
- 35-39
- 40-44
- 45-49
- 50-54
- 55-59
- 60-64
- 65 years or older
- I prefer not to answer

25. Your gender

- Female
- Male
- I prefer not to answer

26. Where are you currently working?

- ☐ Australian Capital Territory
- ☐ New South Wales
- ☐ Northern Territory
- ☐ Queensland
- ☐ South Australia
- ☐ Tasmania
- ☐ Victoria
- ☐ Western Australia

27. Are you a current DAA member?

- ☐ Yes
- ☐ No

28. Please select the source of this survey (Please select all that apply).

- ☐ DAA
- ☐ Dietitian Connection
- ☐ Colleague
- ☐ Other (Please specify:_____)

29. Please provide your mother's maiden name: _____

This will maintain anonymity but enable your responses to be compared and trends identified if you repeat the survey in approximately 2-3 years.

30. Any further comments

_____

Thank you for taking the time to complete this survey.

Appendix I – 2016 Australian Dietitian eHealth (Nutrition Informatics) Readiness Survey

Version 2 March 2016

This survey was adapted from the 2011 nutrition informatics survey developed by the Academy of Nutrition and Dietetics Nutrition Informatics Committee and Healthcare Information Management & Systems Society (HIMSS) Analytics.

Contact author: Kirsty Maunder, University of Wollongong, km932@uowmail.edu.au

1. **Which of the below best describes your current primary practice area?** (Please select only one option).

   - ☐ Clinical nutrition
   - ☐ Community and public health
   - ☐ Consultation and business/private practice
   - ☐ Education
   - ☐ Research
   - ☐ Foodservice
   - ☐ Food industry
   - ☐ Informatics
   - ☐ Dietetic student
   - ☐ Mixed practice (regularly undertaking 3+ areas of work)
   - ☐ Retired (exclude)

☐ Do not work in nutrition and/or dietetics

☐ Other (Please specify:_____)

2. **Please indicate the level of experience you have with retrieving and using electronic data (e.g. using a computer).**
    - 1 – No experience
    - 2
    - 3
    - 4
    - 5 – Highly experienced
    - Don't know

3. **In your primary work setting, do you have <u>access</u> to electronic data (using a computer, mobile computing devices, etc) somewhere at your work place at the time when you need it to do your job?**
    - Yes
    - No
    - Don't know
4. **Do you have <u>access</u> to electronic data (using a computer, mobile computing devices, etc) to support your educational pursuits?**
    - Yes
    - No
    - Don't know

5. **By which mechanism/s do you have <u>access</u> to electronic data at your work place at the time you need it to do your job?** (Please select all that apply).
    - Dedicated computer in my office (e.g. desktop/laptop computer)
    - Mobile computing device (e.g. iPad, smart phone)
    - Shared workstation (e.g. shared department computer, computer at nursing station, workstation on wheels)
    - Smart board (e.g. interactive whiteboard)
    - Other (Please specify: _____)

6. **By which mechanism do you have <u>access</u> to electronic data in order to accomplish your educational pursuits?** (Please select all that apply).
    - Personally-owned computer (e.g. desktop or laptop)
    - Workplace or university provides me a computer for use
    - Shared workstation (e.g. shared department computer lab)
    - Mobile computing device (e.g. iPad, smart phone)
    - Smart board (e.g. interactive whiteboard)
    - Other (Please specify: _____)

7. **Below are listed a number of areas in which you may require data to support your daily work activities. Through what means have you accessed this type of data in the past six months? For each area, please select all means for which you have accessed data. If you haven't accessed this data in the past six months, please check "not used in the past six months".**

Source of data	Electronically via computer or electronic mobile devices	Paper	Direct interaction (i.e. verbal communication with colleagues, presentations, webinar or pod-cast)	Not used in the past six months	Not applicable in my daily work activities
Billing					
Budget					
Continuing professional education					
Data/information from patients and clients					
Patient data/ information from other professionals					
Diet manual/nutrition care manual					
Drug data/information					
Evidence-based library					
Inventory					
Lay literature					
Nutrient database					
Patient educational materials					
Professional journals					
Project management					
Purchasing					

Recipes/menus					
Sales					
Schedules					
Social Media (i.e. social networking sites, blogs)					
Standards of practice					
Standardised Terminology (i.e. NCPT)					
Textbooks					
Work load statistics					

8. **Please indicate how much you agree or disagree with the following statement: *"I use data and technology available to me to problem solve."***
    - 1 – Strongly disagree
    - 2
    - 3
    - 4
    - 5 – Strongly agree
    - Don't know

9. **Please indicate how much you agree or disagree with the following statement: *"I use data and technology available to me for decision making."***
    - 1 – Strongly disagree
    - 2
    - 3
    - 4
    - 5 – Strongly agree
    - Don't know

10. **Please indicate which of the following technologies or computer applications you have used in the past six months to support your daily work activities.**

Technology or Computer Application	Yes	Not in past six months	Not applicable in my daily work activities
Business management (budget, accounting, billing)			
Clinical nutrition management (patient screening & assessment, nutrient analysis, nutrition care manual, evidence-based practice, nutrition counselling)			
Data analysis (spreadsheets, statistical tools)			
Diet office management (menu correction, patient card files, tray service)			
Electronic health record (an environment including ancillary data, clinical data repository, clinical decision support, computerised provider order entry, physician documentation)			
Personally Controlled Electronic Health Record (an electronic collection of data about an individual's health and health care managed by the individual)			
Foodservice management (recipe production, menu planning, inventory, purchasing, receiving, sales, production)			
Human resources management (schedules, workload statistics, payroll)			
Project management (project implementation schedules, project tracking)			
Web tools for collaboration, communication and education			
Other			

11. **What methods for patient consultations do you offer?** (Please select all that apply).

- Phone
- Video (eg. Skype or videoconferencing)
- Email
- Face-to-face
- Other (Please specify: _____)
- Not applicable (don't conduct patient consultations) (Go to Q14)

12. **Which of the following methods do you use for documenting and analysing patient data during patient consultations?** (Please select all that apply).
    - Software/computer programs (eg. Kalix, FoodWorks)
    - Mobile device apps (eg. eNutrition, Dietitian's App)
    - Paper
    - Other (Please specify: _____)
    - Not applicable (don't conduct patient consultations)

13. **What do you recommended to patients for assisting in their nutrition data collection or monitoring?** (Please select all that apply).
    - Software/computer programs
    - Mobile device apps (eg. MyFitnessPal)
    - Mobile devices (eg. FitBit)
    - Paper records
    - Other (Please specify: _____)
    - Not applicable (don't conduct patient consultations)

14. **Describe your comfort level with using technology or computer applications for each of the items below.** (For each item, please select the one best descriptor - beginner, intermediate or expert. If you do not use the technology or computer application, select "no experience".)

Technology or application	**Beginner** I need lots of support	**Intermediate** I can handle most tasks	**Expert** My colleagues come to me for help	**No experience**	**Not applicable in my daily work activities**
Billing					
Budget					
Creating pod casts					
Inventory					
Menu development					
Menu selection					
Nutrient analysis					
Nutrition assessment					
Nutrition histories					
Nutrition screening					
Patient care plans					
Project management					
Purchasing					
Recipe development & management					
Slide presentations					
Spreadsheets					
Social media (blogging/social networking sites)					
Statistical analysis					
Web authoring tools					
Web/internet					
Webinars					
Word processing					
Other					

15. **What are the reasons/barriers (personal or work related) for not using information technology in your practice or for your education needs?** (Please select all that apply).
    - Training issues (none available, too expensive, no time to train)
    - Employer issues (not required for use, doesn't provide IT, lack of staff to support IT)
    - Technology equipment issues (technology is too costly/complex, too many options available)
    - Personal preference (don't like technology, haven't needed to learn to use IT, benefits not well defined)
    - Access issues (no computer at workplace, workflow is not conducive to use of IT)
    - Financial issues (can't afford the initial or continued investment)
    - No suitable solution (can't find software to meet your operational needs)
    - Implementation concerns (too difficult to implement a new system)
    - Don't know
    - Other (Please specify:_____)
    - OR – There are no barriers

16. **In which areas does information technology benefit your work as a dietetics/nutrition professional or student?** (Please select all that apply)
    - Improved access to patient data
    - Improved access to research/education materials
    - Enhanced time management
    - Improved workflow efficiency
    - Performance improvement
    - Reduction/prevention of medical errors
    - Improved patient safety/quality of care
    - Improvements in ability to compile/analyse data
    - Improved communication between care provider/patient
    - Increase my patients' engagement in managing their health
    - Don't know
    - Other (Please specify: _____)

- OR – There are no benefits

17. **What is your level of involvement at your organisation with each of the below, as part of your daily activities?** (Please select one option for each type of task).

Task	Decision maker	Makes recommendations	No role	Not applicable in my daily work activities
Change management				
Hardware selection				
Database management				
Data standards				
Developing terminology				
Interfacing systems				
Mobile computing device/smart phone selection				
Project management				
Social media sites managing				
Software selection				
Software implementation				
Software training				
Software support and maintenance				
Software development				
Software enhancement and/or optimisation				
Web-site development				
Web-site management				
Workflow design				
Other				

18. Would the following help support the use of information technology for your daily activities? (Please select one answer for each item).

ITEM	Yes	No	Not sure	Not applicable in my daily work activities
Provide journal articles on information technology				
Provide professional development session(s) on using technology				
Provide professional development session(s) on nutrition informatics				
Provide reference materials on nutrition informatics				
Provide certification in nutrition informatics				
Provide standards of practice for nutrition informatics				
Electronic health record training/practice application				
Interest Group events and workshops				
Other				

19. Please indicate the level of integration of your electronic health record (EHR) at your organisation. My work/education setting… (Please select only one answer).

Definition: *The Electronic Health Record (EHR) is a longitudinal electronic record of patient health data generated by one or more encounters in any care delivery setting. Included in this data are patient demographics, progress notes, problems, medications, vital signs, past medical history, immunisations, laboratory data and radiology reports. The EHR automates and streamlines the clinician's workflow. The EHR has the ability to generate a complete record of a clinical patient encounter - as well as supporting other care-related activities directly or indirectly via interface - including evidence-based decision support, quality management, and outcomes reporting. Healthcare Information Management and Systems Society).*

- Is beginning to think/talk about building an EHR.
- Is soliciting for applications/evaluating vendors.
- Has purchased an EHR but have not implemented.
- Uses an EHR which has nutrition related functions including diet orders and clinical documentation, but does not include structured Nutrition Care Process Terminology (NCPT).
- Uses an EHR with structured screens for NCPT.
- Isn't a patient care setting that has EHRs.
- Don't know.

20. Have you heard of nutrition informatics?

- Yes (Please specify where: _____)
- No

21. Have you experienced a nutrition-related IT system implementation in your practice area in the last 3 years?

☐ Yes (Go to Q22)

☐ No (Go to Q24)

22. If yes to Q21, list the IT system and the three main problems that arose, and how were they overcome:

IT System: _____

4. Problem:_____
   Resolution:
   _____
5. Problem:
   _____
   Resolution:
   _____
6. Problem:
   _____
   Resolution:
   _____

   OR SPECIFY - 'no problems': _____

23. If yes to Q21, list two project factors implemented well, and the resulting benefits? (Example of factors: project staffing, communication, management involvement, vendor support).

3. Factor:
   _____
   Benefit:
   _____
4. Factor:
   _____
   Benefit:
   _____

24. If you work in a patient care setting, what is the main type of menu used for patients?

☐ Cycle menu

☐ Restaurant style (fixed a la carte menu repeated daily)

☐ Other (Please specify: _____)

☐ Not applicable (not in a patient care setting) (Go to Q27)

25. If yes, what system is used? (Please select all that apply).

☐ Paper menu – standard printed menus (manual system)

☐ Personalised paper menu – printed from a software system (Please specify system:_____)

☐ Bedside computer entry by Nutrition/Foodservice staff (Please specify system:_____)

☐ Bedside computer entry by patient (Please specify system:_____)

☐ Room Service (Please specify system:_____)

☐ Not applicable (not in a patient care setting)

DEMOGRAPHICS

26. Select your age category

- Under 25 years
- 25-29
- 30-34
- 35-39
- 40-44
- 45-49
- 50-54
- 55-59
- 60-64
- 65 years or older
- I prefer not to answer

27. Your gender

- Female
- Male
- I prefer not to answer

28. Where are you currently working?

☐ Australian Capital Territory

☐ New South Wales

☐ Northern Territory

☐ Queensland

☐ South Australia

☐ Tasmania

☐ Victoria

☐ Western Australia

29. Please provide your mother's maiden name: _____

This will maintain anonymity but enable your responses to be compared and trends identified if you repeat the survey in approximately 2-3 years.

30. Any further comments

_____

Thank you for taking the time to complete this survey.

Appendix J – 2016 Australian Dietitian eHealth (Nutrition Informatics) Readiness Survey Grouped into Framework Dimension Categories

#	Question	Demographics	Access	Usage/ Application	Attitude	Aptitude	Advocacy	NA
1	Which of the below best describes your **primary practice area**?	✓						
26	Select your **age** category	✓						
27	Your **gender**	✓						
28	**Where** are you currently working? *(Aus State)*	✓						
3	In your primary work setting, do you have **access** to electronic data (using a computer, mobile computing devices, etc) somewhere at your work place at the time when you need it to do your job?		✓					
4	Do you have **access** to electronic data (using a computer, mobile computing devices, etc) to support your educational pursuits?		✓					
5	By which mechanism/s do you have **access** to electronic data at your work place at the time you need it to do your job?		✓					
6	By which mechanism do you have **access** to electronic data in order to accomplish your educational pursuits?		✓					
19	Please indicate the level of **integration** of your electronic health record (EHR) at your organisation.		✓					

7	Below are listed a number of areas in which you may require data to support your daily work activities. Through what means have you **accessed** this type of data in the past six months?			✓				
10	Please indicate which of the following technologies or computer applications you have **used** in the past six months to support your daily work activities.			✓				
11	What **methods** for patient consultations do you offer?			✓				
12	Which of the following **methods** do you use for documenting and analysing patient data during patient consultations?			✓				
13	What do you recommended to patients for **assisting** in their nutrition data collection or monitoring?			✓				
8	Please indicate how much you agree or disagree with the following statement: *"I use data and technology available to me to problem solve.*"				✓			
9	Please indicate how much you agree or disagree with the following statement: *"I use data and technology available to me for decision making."*				✓			
15	What are the **reasons/barriers** (personal or work related) for not using information technology in your practice or for your education needs?				✓			
16	In which areas does information technology **benefit** your work as a dietetics/nutrition professional or student?				✓			
20	Have you **heard** of nutrition informatics?				✓			

2	Please indicate the level of **experience** you have with retrieving and using electronic data (e.g. using a computer).					✓		
14	Describe your **comfort level** with using technology or computer applications for each of the items below.					✓		
21	Have you **experienced** a nutrition-related IT system implementation in your practice area in the last 3 years?					✓		
17	What is your **level of involvement** at your organisation with each of the below, as part of your daily activities?						✓	
18	Would the following help support the use of information technology for your daily activities?							✓
22	If yes to Q21, list the IT system and the three main problems that arose, and how were they overcome:							✓
23	If yes to Q21, list two project factors implemented well, and the resulting benefits? (Example of factors: project staffing, communication, management involvement, vendor support).							✓
24	If you work in a patient care setting, what is the main type of menu used for patients?							✓
25	What system is used? *Linked to Q24*							✓
29	Please provide your mother's maiden name:							✓
30	Any further comments							✓

Appendix K – Nutrition Informatics Expert Interview Questions

Welcome and overview of what is encompassed by eHealth and the background to this research.

1. What is your current position?

2. What do you see are the **benefits** of eHealth for dietitians?

3. What attributes would you consider reflects a **professions readiness** for eHealth?

4. Based on these attributes, do you feel Australian **dietitians are ready** for eHealth?

5. The results of the national nutrition informatics survey showed that dietitians predominantly have 'no role' in relation to involvement at their organisation regarding technology.
   What are the reasons you feel **dietitians are not initiating and driving** nutrition-related eHealth projects?

6. Of the possible reasons you haven't listed, do you feel any of the following are also important?

Reason	**Important** *Already stated in Q13 Y = Yes N = No
Unaware of the initiatives	
Lack of awareness of the benefits	
Lack of awareness of the risks	
Insufficient training/don't have the skills	
Lack of confidence	
Insufficient time	
Don't consider it a priority	
Interoperability issues	
Don't feel there is a technological/software solution	

7. If you've been involved in an eHealth project, what **difference did your/dietitian involvement have** to the project?

8. What do you think the **risks** are for dietitians not being more involved in eHealth initiatives?

9. Do you feel **optimistic** that Australian dietitians are going to be sufficiently ready for eHealth?

10. What do you think the profession can do to **improve our/dietitians ability or willingness** to take on more advocacy and leadership roles in eHealth?

11. Do you have any **further comments**?

Appendix L – Database Search Strategy

Database	Details	Search Strategy
CINAHL	Technology and setting related keywords	1 AB eHealth 2 AB health informatics 3 AB medical informatics 4 AB health information technology 5 AB health information system* 6 AB hospital information system* 7 1 OR 2 OR 3 OR 4 OR 5 OR 6
	Process related keywords	8 AB readiness 9 AB preparedness 10 8 OR 9
	Search limiters	11 7 AND 10 12 Limit 11 to Language: English
Medline	Technology and setting related keywords	1 AB eHealth 2 AB health informatics 3 AB medical informatics 4 AB health information technology 5 AB health information system* 6 AB hospital information system* 7 1 OR 2 OR 3 OR 4 OR 5 OR 6
	Process related keywords	8 TI readiness 9 TI preparedness 10 8 OR 9
	Search limiters	11 7 AND 10 12 Limit 11 to Language: (English)
Scopus	Technology and setting related keywords	1 eHealth.ab 2 health informatics.ab. 3 medical informatics.ab. 4 health information technology.ab. 5 health information system$.ab. 6 hospital information system$.ab. 7 1 OR 2 OR 3 OR 4 OR 5 OR 6
	Process related keywords	8 readiness.ti. 9 preparedness.ti 10 8 OR 9
	Search limiters	11 7 AND 10 12 Language: English
Web of Science	Technology and setting related keywords	1 TS eHealth 2 TS health informatics 3 TS medical informatics 4 TS health information technology 5 TS health information system* 6 TS hospital information system* 7 1 OR2 OR 3 OR 4 OR 5 OR 6
	Process related keywords	8 TI readiness 9 TI preparedness 10 8 OR 9
	Search limiters	11 7 AND 10 12 Limit S11 to Language: (English) 13 Indexes = SCI-EXPANDED, SSCI, A&HCI, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, IC

Abbreviations: ti/TI = article title, ab/AB = abstract, TS = topic subject